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SIRIUS IN ANCIENT TIMES.

T. J. J. SEE.

For Popular Astronomy.

It has been suggested that an account of the astronomical records of Sirius in the different ages would be of interest to the readers of Popular Astronomy and especially if this would explain the season known as "dog days," whose origin is lost in antiquity. At the request of the editor we shall endeavor to place before the readers of Popular Astronomy a simple *resumé* of the results of historical research so far as it bears upon this subject. And at the outset it may be stated that in our opinion, the terror of the "dog star" arose originally from the fact that Sirius was a red star, and this fiery object was naturally but incorrectly supposed to add fury to the heat of the Sun at the time of heliacal rising (July and August). This belief of the ancients was based on the red color of the star and the coincidence of this heliacal rising with the hottest season of the year, when the Earth was generally consumed with burning droughts, and fevers were prevalent through the ancient world.

Accordingly, we shall first give an account of the ancient observations of the color of Sirius, which, whatever be their explanation, must always remain of great interest.

Modern observers since the time of Tycho have uniformly regarded Sirius as a very white star, and we do not find among the Arabian astronomers from the eighth to the twelfth centuries any record that the color was different in the era of Saracen splendor. But on the other hand, the testimony of the ancients seems very conclusive that the color of the star must have been red in the time of the Roman emperors. We find (compare the writer's "*History of the Color of Sirius*," *Astronomy and Astro-Physics*, April and May, 1892) that the earliest certain allusions to Sirius are in Homer; and although the poet does not record any color, he compares it to Diomede's shield (of copper), and says (in another place) that the "Dog of Orion is very brilliant, but of evil omen, and much *fever* (the word means something fiery) to wretched mortals brings." No great importance is to be attached to such a poetical allusion, but we may observe that Homer is acknowledged to be proverbially exact in his des-

criptions, and the above passage is especially interesting as showing that Sirius was looked upon as an evil omen in the earliest times.

Hesiod first uses the word *Sirius*, and it appears fairly well proved that this meant originally the "burning one," just as Mars was called Puroeis (the fiery one). Hesoid says "Sirius burns the face and knees"—an expression which only indicates that Sirius was closely associated with the hot season of the year.

It may be noted that in one place Euripides refers to Sirius as "sending flames of fire" from the heavens, while Appollonius Rhodius speaks of "Sirius burning the islands of Minos."

The Greek poet Aratus in his description of the constellations calls Sirius "colored," and Cicero translated the word used by Aratus into "shining with a ruddy light." Germanicus Cæsar also translated Aratus, and gives an equivalent expression—"the dog is urged in a ruddy course through the sky."

Now there is every reason to believe that Cicero was well acquainted with the appearance of the star, because of his study of the Greek philosophy which was so much occupied with the heavenly bodies; while on the other hand Germanicus is known to have been an observer who had a good knowledge of the sky.

Therefore it is hardly conceivable that both of these scholarly translators would have misled their readers regarding the familiar dog star.

The Greek astronomer Geminus thought it necessary to refute the common fallacy of his time, which ascribed the heat of the dog days to the influence of the burning dog star. He says: "For this star (Sirius) is of the same nature as all the other stars. And whether the stars are fiery or clear, all have the same power, and exhalations ought to proceed from the multitude of the stars rather than from Sirius." This contrast of Sirius with the multitude shows indirectly and hence the more conclusively that its color must have been fiery red, while the multitude of stars were white; and the way in which the statement is made indicates that this fact was well known to all observers.

The poet Horace says: "Here in a quiet valley, you will escape the heat of the dog star;" again "the fierce hour of the burning dog star cannot touch you." In another place he adds: "whether the red dog cleaves infant statues"—referring apparently to the effects of the great heat of dog days. Of course Horace is not astronomical authority, but there can be no doubt that he was familiar with the appearance of Sirius.

The philosopher Seneca, in discussing various natural phenomena, says: "It is not wonderful if all manner of earth and manifold evaporation exists; since in the heavens also there is not one color of things, but the redness of the dog star is deeper, that of Mars milder, that of Jupiter nothing at all, the splendor being turned into pure light." The deliberate way in which this statement is made must entitle it to the very highest consideration.

The naturalist Pliny says the Etesias (northern winds) occur about the time of the rising of the dog, the hottest time of the year, and that the "vapor of the Sun, produced by the heat of the star, is believed to soften them."

In another place Pliny says that "at the time of the burning Sirius, mad dogs are troublesome to man, and fear water with the dread of death." To judge whether Pliny is reliable in matters of color, we may observe that in speaking of the star Canopus he calls it simply "large and bright," so that he ought not to be expected to call a star like Sirius "burning," if it were merely briliant. Pliny also assigns correct colors to the planets, and observes that when the Sun is rising it is "burning," afterwards "bright."

The Romans held certain agricultural festivals in May, and from Ovid we learn that dogs were offered up in sacrifice for the dog in the sky.

The grammarian Festus says:—"There is a gate at Rome called the Catularia, because not far from it, to placate the dog star, which is hostile to fruits, ruddy dogs are sacrificed in order that the blooming fruits may be brought to maturity."

Again, Festus adds:—"Ruddy dogs, that is not far from a red color, are sacrificed, as Ateius Capito says, in the canine sacrifices for saving the fruits on account of the dog star."

Pliny says that these festivals were instituted at the bidding of the oracle of the Sibyl, in the year of the city 516 (B. C. 238); and we know that they continued for centuries. Now there is no conceivable reason why the Romans should sacrifice red dogs, except that Sirius was red, and dogs of the same color must be offered up to the dog in the sky. The object of the sacrifice seems to have been to placate the ruddy (angry) dog in the heavens, so that when it rose with the Sun some months latter the heat and drought would not blast the fruits.

There can be no doubt that many of the ancients looked upon red stars as angry deities. Thus many of the philosophers praise the stars as blessed gods, and Cicero declares that Mars is "ruddy and terrible to the Earth." This planet came to be associated

with the god of war, because its color suggested blood. In like manner it is recorded that the astrologers assign all manner of evil to the Scorpion, owing, without doubt, to the ruddy Antares, which derives its name from Anti-Ares, the rival of Mars.

The astrologers maintained, we are told, that the "influences" of Jupiter and Venus were "salutary," because their clear brilliant light closely associated them with the sky, of which Jupiter was the principal deity. The astronomical writer Cleomedes has left us a record that Antares and Aldebaran "are of the same size and color as Mars." These results indicate with strong emphasis that the colors of the heavenly bodies were well known to the ancients, and, so far as the writer has been able to find, no important errors in color have been recorded by the authors who have described astronomical phenomena. *In no case is Sirius called white*!

But in several cases this color is ascribed to the planets (Mercury, Venus, etc.,) and Eratosthenes notes the whiteness of Vega, which is seldom observed at all, and if observed is ordinarily described as "bright."

But of all the ancient astronomical authorities, the astronomer Ptolemy is easily first. He classes Sirius as a red star, and thus puts it in the same category with Antares, Aldebaran, Betelgeux, Pollux and Arcturus, all of which are still conspicuously red. Ptolemy enumerates the stars in the constellation of the dog, and speaks of Sirius as:

"The very brilliant star in the month, called the dog, and fiery red."

Some years ago the celebrated Danish astronomer Schjellerup tried to show that this record of Ptolemy was not genuine, but had been accidentally falsified by the error of some scribe since Arabian times. The critical investigations of the writer (*Astronomy and Astro-Physics*, May 1892, p. 381) have, however, shown beyond doubt that Schjellerup was misled by a false translation in one of Albategnius' works published in the middle ages by Plato Tibertinus; and thus it is rendered apparently certain that Ptolemy classed Sirius as fiery red.

From the time of Ptolemy to the time of the Arabians, in the 9th and 10th centuries, the records of the heavens are rare and worthless, so that Ptolemy, who lived in the time of the emperors Hadrian and Antonine, is the last and greatest authority for the ancient redness of Sirius. The celebrated Arabian astronomers, Albategnius, Alfraganus, Al Sûfi, and Ulugh Beigh all note Sirius as "very brilliant," but say nothing of the color. Al Sûfi, who

wrote a description of the fixed stars similar to the catalogue of Ptolemy, notes the red color of Betelgeux, Aldebaran, Pollux, Arcturus, Antares and, wonderful to relate, Algol! Alfraganus speaks incidentally of the color of Antares, Pollux and Aldebaran, while Ulugh Beigh records the red color of Antares, Aldebaran, Pollux and Betelgeux. Thus the Arabians throw no light upon the ancient color of Sirius; and we ought perhaps to conclude from their silence that the star was white or at least not conspicuously red in the tenth century. When the change of color took place, or the physical cause of the change, is entirely obscure; but so remarkable a fact as this change of color must always remain one of the most wonderful phenomena recorded in the annals of science.

It is of course incredible that so many independent observers and writers of high authority would commit the colossal blunder of calling a bluish white star fiery red; and especially as they expressly compare it in several cases with Mars and other stars which are still red. So that we cannot doubt that the red color of Sirius was universally known and recognized in antiquity; but even if we did not credit Seneca, Pliny, Ptolemy, Geminus, Cicero, Germanicus and Horace, we should still have to explain the sacrifice of red dogs to "placate the dog star," of which Festus has left us such explicit record.

Moreover, by the legitimate principles of historical research, we must adhere to the evidence, unless there is reason to suspect its trustworthiness; and we could, on the evidence, more easily prove that Antares was white in antiquity than that Sirius was. But as Antares is red now, no one will doubt that it was red in Roman times. On the other hand many find it hard to believe that Sirius was formerly red, since it is now white, and we are unable to explain how so great a change could take place in the interval of time which has elapsed since classic antiquity. But we must always remember that our inability to explain a fact is no argument against the fact itself. If we cannot understand so great a change in the short space of 2000 years, we need only to recall that everything is possible in the heavens, and our ignorance of the physical causes which operate in the stars is immense. If an explanation of the cause is not forthcoming, we must at present be content simply to establish the fact, and leave the explanation to future ages.

Therefore it seems in the highest degree probable that the ancient color of Sirius was in a large degree responsible for the evil forebodings and superstitious terrors which have always pre-

vailed regarding the dog star and dog days. For of course the name dog days has descended to us from the Romans through the astrology of the middle ages, and although it happens that the evils (great heat, droughts, fevers, &c.) naturally attending that season of the year would make it a dreaded season, this dread in modern times is only of the season, and not of the star, or if a slight dread of the star still lingers, it is due solely to the influence of astrology, which will always flourish while ignorance of natural phenomena continues to exist.

Of course no one in our time except an astrologer would ever explain the heat of summer by the influence of Sirius, and not even an astrologer could now say the star is red. If Sirius had been white in antiquity we might understand how the dog days would be a dreaded season, just as our sailors now dread certain seasons of the year which are fraught with unusual disaster, but we could not understand why this star should be held responsible for all the evil, especially since a white star would have a "salutary" appearance like Venus and Jupiter.

On the other hand, since Sirius was probably red, it was looked upon as an angry deity, and forebodings of its evil influence would naturally arise and continue to flourish.

The season known as dog days (dies Caniculæ) is so called from two circumstances: (1) the heliacal rising of the dog star occurs at this time of the year (July 20th); (2) the ancients were accustomed to mark the seasons by the heliacal rising of certain bright stars near the zodiac.

The ancient priests observed these stars in the morning dawn, and a certain period (40 days) was fixed as dog days, because the dog star was at that time the principal star by which they reckoned the motion of the Sun or the flight of the season.

It would of course be some time after conjunction (now about July 1st) when the heliacal rising began, because Sirius is considerably south of the ecliptic; and the Sun and Sirius would come to the horizon together only when the Sun's right ascension had considerably surpassed that of Sirius, the exact time required for this gain in right ascension depending on the latitude of the place. Ideler, the historian and chronologist, who critically investigated the observations of the ancients, finds that the heliacal rising of Sirius took place at Heliopolis in Egypt on July 20th. This was the time of the inundation of the Nile, and the beginning of the fixed year, so that it was celebrated in Egypt from the earliest times.

The University of Chicago, Dec. 12th, 1894.

THE ASTROLABE.*

MARGARET L. HUGGINS, LONDON, ENGLAND.[1]

A SUMMARY.

"I nam but a . . . compilatour of the labour of olde Astrologiens. . .
I prey meekly every discret persone that redeth . . . this litel tretis to have my rewde endyting for excused. . . .

—CHAUCER [*Treatise on the Astrolabe, Prologus*].

It would be difficult to say anything new at the present time about the Astrolabe; but it is by no means only what is new that is worth saying.

Much interesting and ever precious intellectual treasure is continually being lost through forgetfulness, and becomes in a sense again new if faithfully set forth once more.

We live it is true in the present, and in it we have to act: but the present is the child of the past, and intimate knowledge of its achievements and failures not only makes clearer our perception of the continuity of human effort and the progressive advance of humanity, but may often guide us with many a hint good for the present,—good for the future. *Experientia docet*: the past is concentrated experience.

The idea of this paper is quite unambitious. A perfect and very charming Astrolabe having been given to Dr. Huggins and myself, I have been led to consider the Astrolabe more closely than I had hitherto done; to look into its literature of "olde bokis;" and to examine many Astrolabes. I have found the subject so fascinating that it seemed to me a short paper summarizing the leading historical and structural particulars relating to the instrument might be useful as well as interesting. The summary is the outcome of study of my own; but I frankly own that I have worked into it whatever struck me in my reading as of value for my purpose. Let not anyone feel robbed! Let all, dead or living, from whom I have borrowed, be wise and call my procedure "conveying,"—conveying, to the end that there may be, as old Sir Thomas Browne hath it,—"no monopoly but a community in learning."

In illustrating the structure of the Astrolabe I have used our own instrument, partly on account of its beauty and perfection; partly because it is a very useful size. Plates XVII, XVIII and XIX represent its back, front and four interior tables or plates. It is made for about latitude 32° N. In diameter it measures just 5 inches, while it has a length of a little over 8. It

* From *Astronomy and Astro-Physics*, No. 130.

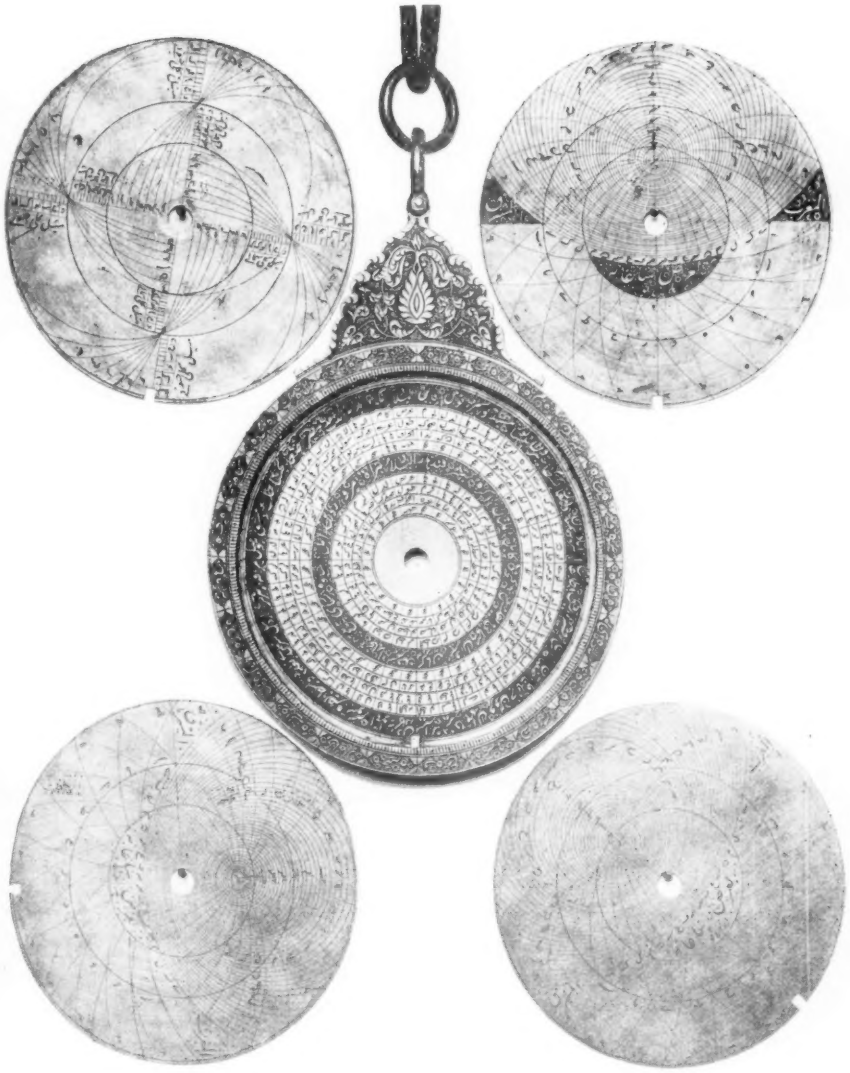
is ⅜-inch thick, and weighs 2 lbs. 2 oz. The material is brass, the work is Persian inscribed in Arabic, and it dates probably from the beginning of the 18th century The engraving on it is excellent and the ornament introduced is skillfully relieved with slight retroussé work. It is very similar indeed in design and in workmanship on a small scale, to the splendid Astrolabe of Shah Husain, King of Persia, now in the British Museum, which was made A. D. 1712 (A. H. 1124) and which is not merely the only "complete" (Tàmm) Astrolabe known, but is also probably the most beautiful one existing.

The usual material for Astrolabes was brass: but sometimes they were of gilded copper, or of hard wood; and sometimes silver inlaying was used. The size varied much. The largest I have seen is one in the British Museum made in London at the end of the 13th century having a diameter of about 18 inches. The next largest I have seen is the one of Shah Husain already referred to, the diameter of which is 16 inches. There were many made of 7 or 9 inches diameter: some much smaller, of 3 or 3½ inches. None I believe have had a diameter less than 2 inches. Upon the whole the oriental ones are the most beautiful; but many European ones are also ornamented; while some oriental ones are very plain.

The student of æsthetics indeed finds much to delight him in the study of Astrolabes. The singular suitability of the instrument for artistic treatment seems to have inspired more or less every maker,—even in times when most instruments were touched with beauty,—and it is rarely that one meets with a specimen without some peculiar charm. The two parts upon which artistic invention and skill were chiefly lavished were the *Kursi* and the *Rete* (see Plates XX and XVII). But the subsidiary parts are often very interesting, and in some French Astrolabes the zodiacal signs are given in animal and human forms which are exceedingly effective. Oriental characters lend themselves of course admirably to artistic effect, and in oriental Astrolabes texts from the Koran are often (surely most suitably) introduced.

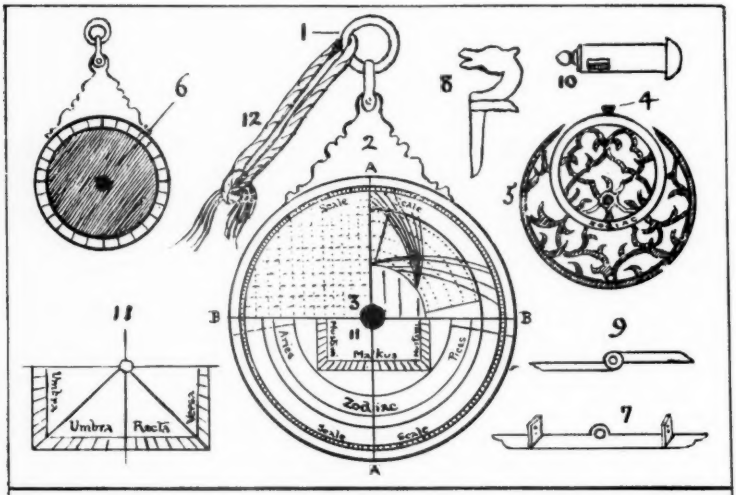
Astrolabes are of two kinds, spherical and planispheric. This paper deals only with the latter to which the term Astrolabe in the 16th and 17th centuries, was practically, exclusively applied. The general appearance and structure of the instrument will be understood from an examination of Plate XVII (face), Plate XVIII (back), Plate XX (index). It consists essentially of a single piece of some weight with a hollow on the *face side* into which fitted certain *Tables* or *Plates*, and an upper piece

PLATE XIX.



THE ASTROLABE: INTERIOR TABLES AND PLATES.

PLATE XX.



Latin	English	Arabic
1. Armilla suspensoria . . .	1. Ring.	1. Halkah.
2.	2.	2. Kursi.
3.	3.	3. Mahan.
4.	4. Calculer.	4. Muri
5. Aranea or Volvellum	5. Rete.	5. 'Ankabút.
6. Mater or Rotula.	6. Mother.	6. Umm.
7. Alidade or Verticulum	7. Rule.	7. 'Izadah.
8. Equus restringens.	8. Wedge.	8. Faras.
9.	9. Label.	9.
10. Axis. Clavus.	10. Pin.	10. Kutb.
11. Scala altimetra or Quadrans.	11. Umbra recta & versa	11. Mustawi & Ma'kús.
12. Tympani.	12. Cord. Tables. Plates.	12. Ilákah. Safáih, plural Safihah.

AA. Linea meridionalis	= Line of Mid-day or South Line	= Khatt Nisf-an Nahar.
BB. Horizon rectus.	= Level Line.	= Khatt al-Istiva

Circuli progressionum	= Almicantars.	= Almucantarát. (Bridges).
Circuli verticales.	= Azimuths	= Sumút.

M. L. Huggins: fecit. 1894

Other plates referred to will appear in next number.

called the *Rete*. The weight of the Astrolabe saved the use of a plumb-line. Plate XX gives an index to the particular parts. The *Rete*, which formed the face of the instrument (see Plate XX), had the names of certain stars on its pointers or projecting pieces, and the *tip* of each projection was understood to give the star's centre. The *Rete* rotated, and the almucantars and azimuths of a table placed underneath it can be seen through the reticulations for fixing the position of stars. The inner circle of the *Rete* contained the Zodiacal signs in degrees.

It is not possible in this Summary to go into minute details, but a few notes in addition to those supplied in Plate XX may be acceptable. Movable indices are not found in Eastern Astrolabes, but they occur in various forms in European instruments. The *Label* (Plate XX), when there was also a *Rule*, was used on the face of the instrument. The parallelogram on the back is almost universally present, but in Eastern instruments there are no lines from the corners to the pole. A figure is given in Plate XX of the European *Umbra Recta* and *Versa* parallelogram. The parallelogram is for measuring heights of terrestrial objects accessible or inaccessible. It is obvious that for altitudes greater than 45° the base lines called *Umbræ rectæ* are used; and the perpendicular sides, the *Umbræ versæ*, for lesser heights than 45°. These lines are divided into 12 parts, and the terms *Umbræ rectæ* and *Umbræ versæ* are borrowed from the Arabic. (For details of the method of working the parallelogram, see Chaucer's Treatise, Part II, § 41-43, Skeat's Edition of Chaucer's Works.) The upper quadrant of the central figure in Plate XX contains sines and arcs for various purposes. The arrangement of the back indeed varied much. The scale of degrees on the circumference was of course an invariable feature; and so was a Zodiacal circle. But the other circles in Eastern Astrolabes might have the days of the year;—lunar mansions, etc., while in European instruments there might be circles of the Saint's days and of Sunday letters.

The *Tables*, *Climates*, or *Plates* differ in number, and also in matter. They were always thin and were varied in use under the *Rete*—the whole series packing into the hollow of the Astrolabe, and the one required for the time being placed uppermost. On some European *Tables*, a map of the World in polar projection was given; but they usually showed projections of the sphere drawn for various latitudes. It was usual to mark the latitude for which each *Table* was constructed, under the horizon obliquus. But even without this it is easy to see at a glance for what latitude a *Table* is drawn by reckoning the degrees from

the zenith to the S. point of the equinoctial or equator, or from the pole to the horizon obliquus. The vertical circles or azimuths cross of course the almucantars or latitude circles, and proceed by intervals of 10 degrees; *i. e.*, every 10th azimuth is traced. Astrological *Tables* are found on both Eastern and Western Astrolabes and relate usually to the zodiac and the planets. In Northern Astrolabes, that is those for use in northern latitudes, the tropic of Capricorn is at the border of the *Tables*. In Southern instruments the tropic of Cancer takes this place.

The term *climate* used above, it may be added, means the belt of the Earth included between two fixed parallels of latitude. In Plate XL is shown a *Table* on a small scale drawn for about latitude 52° N. The east and west of the Astrolabe are read as are dexter and sinister in heraldry, the Astrolabe being supposed to be held as is a shield. Astrolabes are classed in the east according to the number of circles or almucantars inscribed on them.

The Támm or *Perfect Astrolabe* was inscribed with 90 circles each answering to 1°. (One only is known to exist.)
The *Nisfi* or *Bipartite* with 45 circles each answering to 2°.
The *Thulthi* or *Tripartite*, 30 circles each = 3°.
The *Khumsi* or *Quinquepartite* 18 circles each = 5°.
The *Sudsi* or *Sexpartite*, 15 circles each = 6°.

Other modes of inscription were quite uncommon.

It is impossible to handle a good Astrolabe without being struck with its comprehensiveness. It combines in itself quadrant, planisphere, theodolite, globe,—and the combination is a marvel of portability and convenience. It is easy to understand Chaucer calling it a "noble instrument:" it is easy to enter into the feeling of Blagrave who spoke of one form of it as a "mathematical jewel." Alas! that the Astrolabe is not capable of higher precision. [TO BE CONTINUED.]

ON THE VARIABLE STARS OF SHORT PERIOD.

PAUL S. YENDELL.

II.

FOR POPULAR ASTRONOMY.

In the present paper, the original intention of arranging the stars in their order of right ascension has been departed from, for the reason that the next four stars in that order constitute what is sometimes called the "Sagittarius Group," and is not ob-

servable at evening in these latitudes until May or June, while the stars of which particulars are detailed in this paper, and some of those in the next succeeding one can at any rate be identified, and perhaps to some extent observed, after the paper appears.

Of the accompanying charts, that of Aquila and Sagitta is from Klein; that of Cygnus, Lyra and neighboring constellations from Heis. The large-scale charts of S Sagittæ and X Cygni are from the Durchmusterung.

6758. β Lyræ.

R. A. $18^h\ 46^m\ 23^s$ Decl. $+\ 33°\ 14'.8$ (1900).

ELEMENTS OF VARIATION.

GREENWICH M. T.

Minimum, 1855 Jan. $6d\ 14^h\ 28^m.7 + 12d\ 21^h\ 46^m.58\ 3^s$ E.
$+\ 0^s.4217E^2 - 0^s.00007E^3$.

This is the westerly one of the two bright stars southeast of α Lyræ, and may be readily identified by this description. It is one of the oldest known variables. The fact of its variation was discovered in 1784, by Goodricke, of York, England. It was observed by Westphal of Danzig, in 1817-1818. Argelander took it up in 1840, and kept a continuous watch upon it until 1862. His observations, about sixteen hundred in number, are published in Bonn observations, Vol. VII.

Schönfeld observed it in 1859, and later from 1865 to 1868, and the results of his work upon it are to be found in the *Astronomische Nachrichten*, Vol. 75, p. 1. It is his mean light curve, referred to Argelander's light-scale, which is given below.

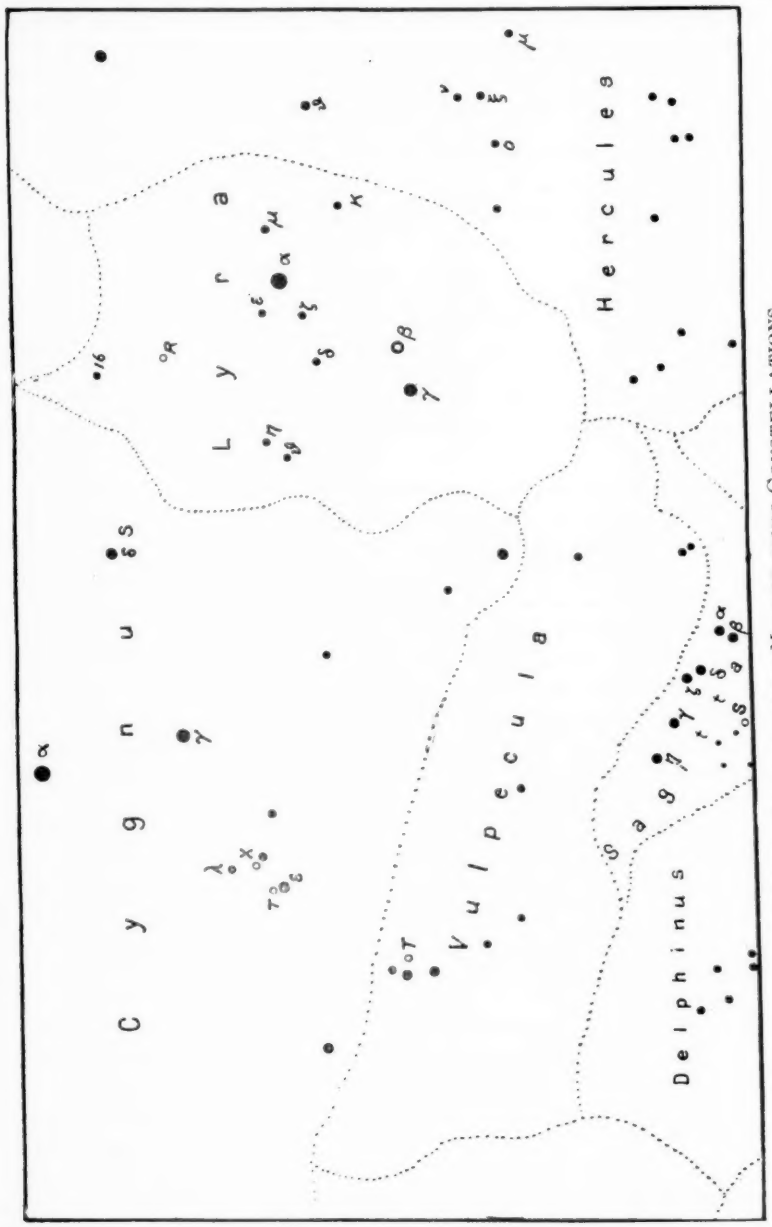
Argelander published two treatises on the star, in 1844 and 1859, which are the foundation of our knowledge of it.

For the past few years it has been observed by Plassmann in Warendorf, Germany, and by Sawyer, Reed and myself in this country; see *Astronomical Journal*, Vol. VIII, p. 69, and Vol. XIV, p. 47.

The star's variation is of a very peculiar character, there being two equal maxima, and two unequal minima in a period of nearly thirteen days. The faintest, or principal minimum is the point of reference for the star's Epoch.

It is easily found and observed, on account of its brightness and for various reasons the naked eye is best fitted for observing it.

The accompanying chart gives sufficient indication of the posi-



CYGNUS, LYRA AND THE NEIGHBORING CONSTELLATIONS.

tions of the variable and its comparison stars to enable the observer to pick it up with ease.

The elements given at the head of this article are Argelander's with Reed's provisional correction, and are taken direct from Chandler's Second Catalogue.

COMPARISON-STARS.

POSITION 1900.

		h	m	s		°	′	Mag.	Light.
γ Lyræ	R. A.	18	55	12	Decl. +	32	33.1	3.5	12.7
ξ Herculis		17	54	24		29	16.9	3.7	10.3
o Herculis		18	3	38		28	44.8	3.8	7.6
ε Lyræ		18	41	00		39	33.7	4.0	4.9
ζ Lyræ		18	41	20		37	30.0	4.3	3.4
$\varkappa$ Lyræ		18	16	21		36	1.8	4.7	2.6

ε and ζ Lyræ are both coarse pairs, but single to the ordinary eye, though Heis said he commonly saw ε double.

LIGHT TABLES.

d.	Lt.	d.	Lt.	d.	Lt.	d.	Lt.	d.	Lt.
0.00	2.75	2.75	12.60	5.25	10.11	7.75	10.63	10.50	12.13
0.25	3.74	3.00	12.69	5.50	9.67	8.00	11.10	10.75	11.91
0.50	4.27	3.13	12.70	5.75	9.30	8.25	11.55	11.00	11.54
0.75	5.88	3.25	12.69	6.00	9.04	8.50	11.93	11.25	10.92
1.00	8.52	3.50	12.62	6.25	8.90	8.75	12.17	11.50	9.97
1.25	10.23	3.75	12.49	6.38	8.88	9.00	12.31	11.75	8.55
1.50	11.05	4.00	12.26	6.50	8.89	9.25	12.38	12.00	6.58
1.75	11.57	4.25	11.99	6.75	9.05	9.50	12.40	12.25	4.80
2.00	11.97	4.50	11.58	7.00	9.32	9.75	12.38	12.50	3.90
2.25	12.27	4.75	11.09	7.25	9.72	10.00	12.35	12.75	3.65
2.50	12.47	5.00	10.58	7.50	10.17	10.25	12.27	12.96	3.62

The dates are reckoned forward from the point of minimum, as in the curve of ζ Geminorum in the last paper.

7124. η AQUILÆ.

R. A. $19^h\ 47^m\ 23^s$ Dec. + 0° 44′.9 (1900).

ELEMENTS OF VARIATION.

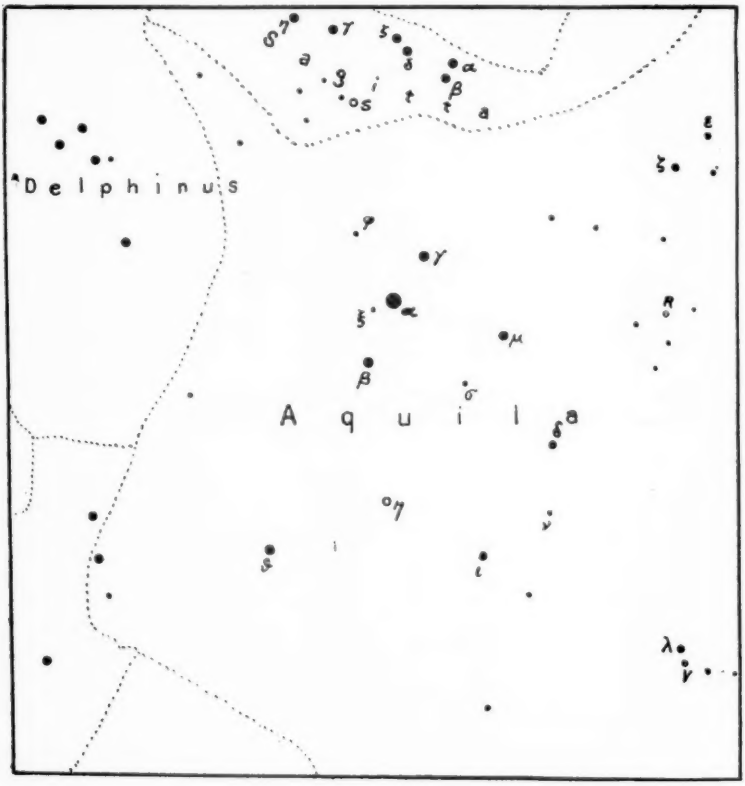
GREENWICH M. T.

Maximum 1888, Jan., $6d\ 12^h\ 32^m + 7d\ 4^h\ 14^m$ 0.0ᵉE.

Minimum precedes maximum $2d\ 9^h$.

η Aquilæ was discovered to be variable by Pigott, in 1784, and is thus one of the oldest known variables.

The star was observed by its discoverer through 1784 and 1785, and by Wurm, Westphal, Oudemans, Argelander, and Schönfeld it has been kept pretty constantly under observation up to 1862, beyond which point I have not searched the records. I observed it in 1888, 1889 and 1890.



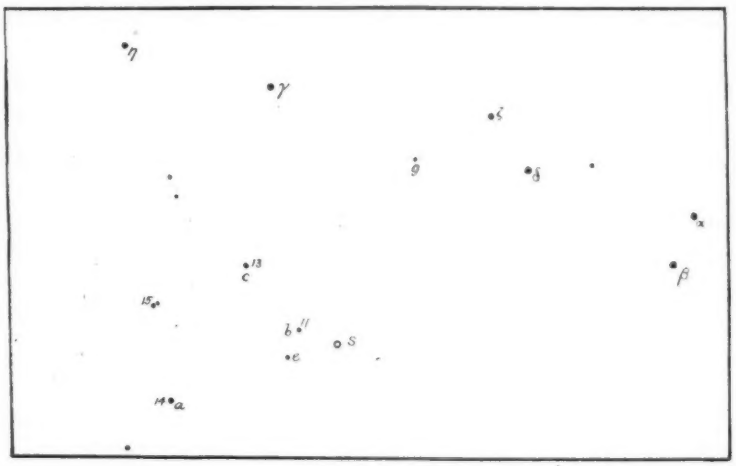
AQUILA, SAGITTA, ETC.

It is readily found, from its position near the first-magnitude star α Aquilæ, and its comparison-stars are also easily picked up, as will be seen by the accompanying chart. I regret to be unable to give any mean light-curve of the star, but I know of no standard one, and my own observations do not furnish sufficient material for the formation of a useful one.

Argelander's comparison-stars and light-scale are:

		Position, 1900.							
		h	m	s		°	′	Mag.	Light.
δ	Aquilæ	R. A. 19	20	27	Dec.	+ 2	54.6	3.3	14.6
β	"	19	50	24		+ 6	9.8	3.9	9.8
ε	"	18	58	25		+ 14	57.9	4.0	7.9
ι	"	19	32	3		− 1	29.8	4.4	4.7
μ	"	19	29	12		+ 7	9.9	4.7	2.2
ν	"	19	21	25		+ 0	8.2	5.1	0.0

The star can be observed most conveniently with the naked eye or an opera-glass.



SAGITTA.

7149. S SAGITTÆ.

R. A. $19^h\ 51^m\ 29^s$ Decl. $+ 16°\ 22'.2$ (1900).

ELEMENTS OF VARIATION.

GREENWICH M. T.

Minimum 1876 Dec. 9.80 + 8.38320E.

This star's variability was discovered by Gore, in 1885. It has been pretty constantly followed by its discoverer, and in this country by Chandler, Sawyer, Reed and myself.

It is readily found and observed with an opera-glass, and the accompanying chart gives all that is necessary for easily finding it.

Its light-curve is peculiar, and in the present state of our knowledge of it, the minimum seems the safest point of reference, although not so sharply defined as is desirable. For the peculiarities of its variation, the reader is referred to No. 321 of the *Astronomical Journal* in which I have discussed the subject, using all the published observations then available.

The comparison-stars and light-scale published in the paper above referred to are:

Position 1900.

	h	m	s	°	′	Mag.	Light.
a = 14 Sagittæ	RA 19	58	56	Dec. + 15	45.7	5.6	11.8
b = 11 "		55	13	16	31.7	5.8	9.9
c = 13 "		55	32	17	14.3	6.1	7.9
e = D.M. + 16° 4086		53	43	16	13.4	7.0	0.0

The star a (= 14 Sagittæ) lies under some suspicion of variability, but this has not been confirmed, and the Potsdam measures are very accordant, and give a value within $0^m.1$ of that given above.

Light Table.

d.	Lt.	d.	Lt.	d.	Lt.
0.0	5.20	3.0	9.35	5.5	8.35
0.5	5.80	3.3	9.28	6.0	7.62
1.0	6.85	3.5	9.32	6.5	6.95
1.5	8.35	4.0	9.70	7.0	6.32
2.0	10.08	4.5	10.60	7.5	5.83
2.4	10.86	4.8	10.86	8.0	5.48
2.5	10.75	5.0	10.33	8.4	5.20

Neighborhood of X Cygni.

7437. X Cygni.

R. A. $20^h\ 39^m\ 29^s$ Decl. + 35° 13′.6 (1900).

ELEMENTS OF VARIATION.

GREENWICH M. T.

Maximum 1886 Oct. 10.55 + 16*d*.389E.
Minimum precedes maximum 6.8 days.

This is one of Chandler's stars, discovered in 1886. I have watched the star pretty constantly since 1888, as has also Sawyer, and Gore to some extent. For my published observations and discussions, see the *Astronomical Journal*, Vols. VIII to XIII. Chandler's announcement of discovery is in the same paper, Vol. VII, p. 32. The supposed periodical variation in mean magnitude, mentioned in Chandler's note to his second catalogue is undoubtedly a subjective phenomenon, for particulars of which, see *Astronomical Journal* Vol. XIV, p. 14. The minima, however, vary irregularly within the limits given in the list published in the first paper of this series.

The star is readily found, being just following the line between ϵ and λ Cygni, about midway, and at the foot of the Y-shaped group formed by itself and its comparison-stars.

The best instrument for observing X Cygni is a good field-glass which will grasp all the faint minima. Its period is of sufficient length to make the graphic method of determining its phases generally sufficient; and in fact no mean light-curve would give satisfactory results, as Chandler (*Astronomical Journal*, Vol. VII, p. 159) says, "the star distinctly belongs to the class whose light-curves are not constant in different periods." No mean curve of the star will therefore be given. The comparison-stars are:

POSITION, 1900.

	°		h	m	s	°	′	Mag.	Light.
a = D.M.	+ 35	4141	RA 20	25	20	Dec. + 36	6.3	6.2	13.6
b = "	+ 34	4127		38	17	35	4.8	6.7	9.4
d = "	+ 34	4111		35	50	35	0.1	6.9	7.0
f = "	+ 34	4114		36	43	34	40.0	7.1	5.0

PRONUNCIATION OF STAR NAMES DERIVED FROM THE ARABIC.

ROBERT H. WEST.

FOR POPULAR ASTRONOMY.

The Arabian astronomers were the connecting link between Greek astronomy and that of the Middle Ages in Europe. The *Megala Suntaxis* of Ptolemy was the basis of their system, and the Almagest, as they called their translation, was one of the

principal bases on which the science was founded in Europe. Astrology was much in vogue among the Arabs at the same time, and much attention was given to studying the configurations of the planets and the constellations, somewhat, but by no means entirely, to the exclusion of the more scientific study of the subject. Hence we naturally find definite names assigned to most of the brighter stars in their various drawings and descriptions of the heavens.

Many of these names were introduced into European languages, mostly through Latin translations of the Almagest and of celestial globes, and through the Alphonsine tables, which were prepared about A. D. 1250 by the order of Alphonso X of Castile, soon after the expulsion of the Moors from Northern Spain, and which were based entirely on the Arabian Astronomy. In this transfer many errors have occurred. The most common of these is the assignation of the name of the constellation to the brightest star in it, as Dubhe, Alphacca, etc., and the appropriation to a single star of the name of the group in which it occurs. In the appended list, some of these groups are referred to as "moon-stations;" these are divisions of the Zodiac, analogous to the well known signs, but 28 in number, one for each day of the sidereal month. Each of these stations was named by the Arabs, and the stars in it referred to as belonging to that station.

As might be expected where the alphabets are so essentially different, the names are very often imperfectly represented by the Latin letters; actual mistakes, as well as omissions of parts of names are not uncommon, and indeed only rarely is the true pronunciation accurately represented. The purpose of the present article is to aid the student to approximate the true pronunciation as far as the ordinary spelling of the names will permit. Not much more can be done than to accent the proper syllables, and to indicate in general the vowel sounds. While the accepted principle in such matters is to approximate the true pronunciation as nearly as may be, it would be folly for any one whose ears and throat are not familiar with Arabic to attempt an exact pronunciation.

In the list below, which is restricted to the names given in Young's Uranography, the proper accent has been indicated, and a careful, though designedly incomplete, transliteration from the original Arabic has been added for the purpose of comparison. The following explanations may be found helpful. There are three fundamental vowel sounds in Arabic, *a* as in *pass*, *i* as in *it*, *u* as in *put*. These are modified by letters adjoining them, espe-

cially when lengthened into ä as in *far*, *î* as *ee* in *feet*, and *û* as *oo*, in *moon*; the diphthong sounds are *ai*, midway between long *a* and long *i*, and *au*, which is as in English. In regard to the consonants, the nearest English equivalent has been given, except for the following: *kh* is a rough palatal *h* of the same character as the Scotch *ch* in *loch*, but stronger; and *gh* and ' represent guttural consonants peculiar to Semitic languages. For the purposes of this article, minor consonantal distinctions, all-important from a philological standpoint, have been entirely ignored. In the names given below, *th* is always hard with a few exceptions noted; *g* should be pronounced soft whenever *j* is found in the corresponding transliteration, hard when it is instead of *gh*. There are no silent letters in the transliteration. *Al* is the definite article, *l* being frequently euphonically changed into the first letter of the succeeding word.

The following authorities have been consulted:

Ideler, Untersuchungen uber den Ursprung und die Bedeutung der Sternnamen, Berlin, 1809. This, the classical work on the subject, is based on Kazwini's description of the heavens, (A. D. 1262), but covers the whole range of the subject, including names derived from the Latin and Greek.

Tabulæ Ulugh Beighi, etc., ed. Thomas Hyde, Oxonii, 1665, containing Ulugh Bey's Star Catalogue, (epoch 1437), in Persian and Latin with a commentary, and with Tizini's Tables, (epoch 1553).

Description des Étoiles fixes par l'Astronome Persan Abd-al-Rahman al-Sûfi. Traduction avec notes par H. C. F. C. Schjellerup. St. Pétersbourg, 1874. Date of the original, A. D. 964.

A'chernar', α Eridani, *Äkher an-Nahr, the end of the river.*

Adar'a, ε Canis Majoris, al-'Athära, *the maidens.* In the original, the name belongs to the group o^2, η, δ and ε.

Ak'rab, β Scorpionis, 'Akrab, *the scorpion.*

Albireo, β Cygni. Notwithstanding its appearance, this name is not derived from the Arabic; its origin is very obscure.

Alchiba', α Corvi, al-Khibä, *the tent*, a name sometimes applied to the whole constellation.

Alcor', —Ursæ Majoris, al-Khawwär, *the faint one*, (Schjellerup). The usual name in Arabic is as-Suha.

Aldebaran', α Tauri, al-Dabarän, *the followers.* This name was frequently, perhaps originally, used for the whole group of the Hyades. The usual pronunciation is Aldebar'an, (Webster).

Alderamin', α Cephei, ath-Thrä' al-Yamîn, *the left arm.*

Algei'ba, γ Leonis, al-Jabha, *the forehead*, taken from the "moon-station," in which are α, γ, η, ζ.

Algen'ib, α Persei, γ Pegasi, al-Janb, *the side*.

Algied'i, α Capricorni, al-Jidi, *the goat*.

Algol', β Persei, al-Ghûl, *the demon*. The full name is Räs al-Ghûl, *the demon's head*.

Algores, (correct form, Algorab'), δ Corvi, al-Gharäb, *the raven*.

Alhen'a, γ Geminorum, al-Han'ah, one of the "moon-stations."

Alioth, ε Ursæ Majoris. So given in the Alphonsine Tables, but its origin is obscure; possibly it is derived from Alya, which see.

Alka'id, η Ursæ Majoris, al-Käid, *the governor or leader*.

Alkes', α Crateris, al-Käs, *the cup*.

Almaach', γ Andromedæ, a corruption of al-'Anäk.

Alnilam, (correct form, Alnidam'), ε Orionis, an-Nizäm, *that which is arranged in order*, as, for example, a string of pearls.

Alnitak', ζ Orionis, an-Nitäk, *girdle*.

Alphac'ca, α Coronæ Borealis, al-Fakka, from the name of the constellation.

Alphard', α Hydræ, al-Fard, *the solitary*.

Alpher'atz, α Andromedæ. Perhaps derived from al-Faras, *the horse* (Pegasus?)

Alphirk', β Cephei, al-Firk, *the flock*, originally used for the group, α, β, η.

Altair', α Aquilæ, (Nisr) at-Täir, *the flying* (*eagle*).

Alwa'id, β Draconis, al-'Awäid.

Al'ya, θ Serpentis, Alya, *tail*, properly used only for the tail of a sheep.

Arided, α Cygni, a mistake in the Alphonsine Tables for Arid'ef, ar-Ridf, *the hinder part*.

Azimech', α Virginis, as-Simäk.

Bat'en Kaitos, ζ Ceti, Batn-Kaitos, *the belly of Cetus*.

Benet'nasch', η Ursæ Majoris, Banät Na'sh, *the daughters of the bier or coffin*, the name sometimes given to all the bright stars of "The Dipper," and sometimes to the three in the handle, but never, in Arabic, to a single star. The correct name for the star is Alkaid, q. v.

Bet'elgeus'è, α Orionis, Ibt or Bät al-Jauzä, *the armpit of the giant* (Orion).

Caph, β Cassiopeiæ, Kaf, *hand*.

Ceb'elra'i, β Ophiuchi, Kelb ar-Rä'i, *the dog of the shepherd*.

Cur'sa, β Eridani, Kursi, *the chair* (*i. e.*, of Orion).

Den'eb Algied'i, δ Capricorni, Deneb al-Jidi, *the tail of the goat.*

Den'eb Cygni, α Cygni, *tail of Cygnus.*

Den'eb Kaitos, β Ceti, *tail of Cetus.*

Den'ebola', β Leonis, Deneb al-Asad, *tail of the Lion*,—the last syllable of the name having been dropped.

Diph'da, β Ceti, Difda' ath-Thäni, *the second frog.* α Piscis Australis is the "first frog."

Dub'he, α Ursæ Majoris, Dub, *the bear.*

El Nath, β Tauri, an-Nätih, *the one who butts*, as a ram; this name belongs to α Arietis.

En'if, ε Pegasi *enf, nose.*

Etanin', γ Draconis, (Räs) at-Tannîn, (*head*) *of the dragon.*

Fomalhaut, α Piscis Australis, Fam al-Hût, *mouth of the whale.* The usual pronunciation is Fomalo, but it is far from the original.

Gomel'za, β Canis Minoris, al-Ghamai'sa, one of the "moon-stations."

Ham'al, α Arietis, Hamal, *the sheep*, the name of the constellation.

Izar', ε Bootis, Izär, *girdle.*

Kaus, λ Sagittarii, Kaus, *the bow.*

Ko'chab, β Ursæ Minoris, Kaukab, *star.* This misnomer, which is very ancient, probably arose from an ignorant appropriation of the word from the name Kaukab ash-Shamali, *the North Star*, sometimes used for Polaris.

Mar'fak, α Persei, marfik, *elbow.*

Mar'fic, λ Ophiuchi, same as Marfak.

Markab, α Pegasi, Markab, *the thing ridden.*

Meboula, ε Geminorum, Mib'wala (?).

Meg'rez, δ Ursæ Majoris, Maghriz, *the root of the tail.*

Men'kalinan', β Aurigæ, Mankib thî-al-'Inän, *the shoulder of him who holds the reins, i. e.*, of Aurigæ.

Men'kar, α Ceti, Mankhar, *the nose or snout.*

Merak', β Ursæ Majoris, Miräk, *groin.*

Min'taka, δ Orionis, Mintaka, *girdle.*

Mirach', β Andromedæ, same as Merak.

Mir'zam, β Canis Majoris, Mirzam, a name given to a fainter star preceding a more brilliant one. β Canis Minoris is another example.

Mîzär, ζ Ursæ Majoris, Mîzär.

Mul'iphen' γ Canis Majoris, al-Muh'lifain.

Muf'rid, η Bootis, Mufrid, *the lonely.*

Nekkar', β Bootis, Nakkär, one of the names given to the constellation.

Pheed'a, (*a* silent), γ Ursæ Majoris, Fakh'ith, *thigh*.

Ras Algeth'i (*th* soft), α Herculis, Räs al-Jäthi, *head of the kneeler, i. e.*, of Hercules.

Ras Alaghue, α Ophiuchi, Räs al-Hawä, *head of the snake charmer, i. e.*, of Ophiuchus. This peculiar and misleading spelling is due to the Alphonsine tables.

Ri'gel, β Orionis, Ri'jal, *foot*.

Rischa', α Piscis Borealis, Rishä, *the cord, i. e.*, which binds the two fishes together.

Saad el Melik, α Aquarii, Sa'd al-Malik, *good fortune of the king*, properly applied to the pair of stars, α and o. There were ten pairs with this name Sa'd. See Scheat.

Saad el Sund, β Aquarii, an error for Sa'd us Su'ûd, *good fortune of good fortunes*, belonging to the pair β and ζ.

Sad'ira, σ Sagittarii, Sädira, *the departing*.

Saiph, κ Orionis, Saif, *sword*.

Scheat, β Pegasi, seemingly a corruption, in certain old globes and maps, for Sa'd. There are two pairs of stars of this name in Pegasus, η and o, λ and μ respectively, and it has been erroneously transferred to β.

Schedir, α Cassiopeiæ, Sudr, *breast*.

Sheratan', β Arietis, ash-Sharatain, the first of the "moon-stations."

Skat, δ Aquarii, origin uncertain, perhaps Sa'd, as above.

Sudr, γ Cygni, Sudr, *breast*. See Schedir.

Te'jat, (*j* as *y*), μ and η Geminorum, at-Tahäyah.

Thuban', (*th* soft), α Draconis, Thu'bän, *dragon*.

Ua'ukulha'i, α Serpentis, 'Auk al-Hauiyah, *neck of the serpent*.

Vega, α Lyræ, (Nisr) al-Wäki, *the falling* (*eagle*). Only the last word has been preserved, meaning falling.

Was'at, δ Geminorum, Wast, *middle*.

Wes'en, δ Canis Majoris, Wazn, *weight*.

Yed, δ Ophiuchi, Yad, *hand*.

Zaurack', γ Eridani, az Zauräk, *the boat*.

Zavijava, (pronounced Za'wiya'wa), β Virginis, Zawiyah al-'Awa, the angel of the 'Awa; al-'Awa was one of the "moon-stations," and included β, η, γ, δ and ε. As is evident the name Zavijava properly belongs to γ.

Zubin'el Genu'bi, α Libræ, Zubän al-Janûbi, *the southern* Zubän. This and the following were "moon-stations."

Zubin'el Shama'li, β Libræ, Zubän ash-Shamäli, *the northern* Zubän.

Syrian Protestant College, Beirut, Syria,
December 7, 1894.

LONG PERIOD VARIABLES.

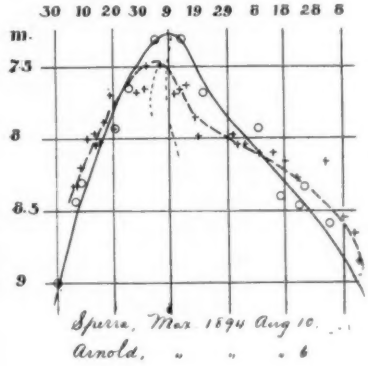
J. A. PARKHURST.

FOR POPULAR ASTRONOMY.

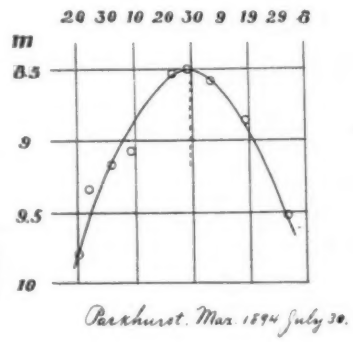
1623 T CAMELOPARDALIS.

Mr. Walter Dearden of Trinidad, Colo., has observed a minimum of this star, occurring 1894, July 16. He watched the star from April 30 to Aug. 25. It was near the limit of visibility of his 9½-inch reflector during July, and consequently below the 13th mag. During August the rise was rapid. The position of this star for 1900 is R. A. $4^h\ 30^m.4$, Decl. $+ 65° 59'$. Three maxima have been observed—1891, Dec. 24; 1892, Dec. 28; and 1894 Jan. 3; but no observations of a minimum have been heretofore published.

3825 R URSÆ MAJORIS.



7118 X AQUILÆ.



3825 R URSÆ MAJORIS.

The past maximum of this star has been observed by Mr. W. E. Sperra, of Randolph, Ohio, who has 13 observations between June 30 and Oct. 3, yielding a maximum of $7^m.2$ 1894, Aug. 10. It was also observed 32 times from July 6 to Oct. 14 by Mr. F. F. Arnold, of Rockford, Ill., who deduces a maximum of $7^m.5$, 1894, Aug. 6th.

In the accompanying light-curve of 3825 R Ursæ Majoris the small circles represent the observations of W. E. Sperra, and the full line the corresponding curve, showing a maximum 1894, Aug. 10. The crosses and the broken line represent the work of F. F.

Arnold, showing a maximum 1894, Aug. 6. The close agreement with Chandler's prediction (Aug. 8) is worthy of notice; also the fact that both curves show a more rapid decrease in light during the 20 days following the maximum than during the next 30 days.

4511 T Ursæ Majoris.

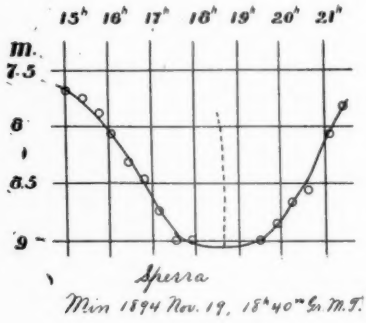
Mr. Sperra has 10 observations between July 26 and Oct. 17 giving a maximum of $7^m.2$, 1894, Aug. 21, only 4 days after the predicted time.

4557 S Ursæ Majoris.

Mr. Sperra has 15 observations between June 2 and Oct. 4, giving a maximum of $7^m.7$, 1894, Aug. 13, also 4 days after Chandler's prediction.

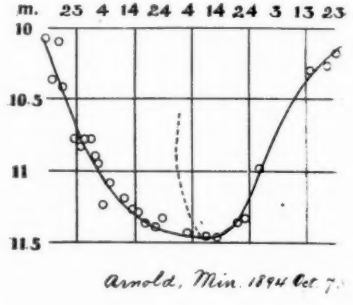
320 U. Cephei.

1894, Nov. 19.



7085 R T Cygni.

1894. Sept. Oct. Nov.



7118 X Aquilæ.

The position of this new variable for 1855 is R. A. $19^h\ 44^m.3$ Decl. $+ 4° 5'.9$. Its variability was discovered from the Harvard photographs and confirmed by Mr. Yendell. I have 9 observations between June 20 and Sept. 1. The star rose from about the 11th magnitude to a maximum of $8^m.5$, 1894, July 30, and then fell to about the 10th magnitude when last observed.

Mr. Arnold's excellent determination of the minimum of 7085 R. T. Cygni, 1894, Oct. 7, is 36 days later than Chandler's prediction, but the elements are only approximate, being based on 4 maxima and only 2 minima. The maximum observed last June was 13 days later than the ephemeris.

Mr. Sperra's minimum of 320 U Cephei is a good example of

what can be done with a variable of the "Algol type" in 6 hours. His time agrees well with the ephemeris, Chandler's prediction being $18^h\ 28^m$, while Mr. Yendell observed the same minimum and got $18^h\ 44^m.5$.

SUMMARY OF OBSERVED MAXIMA AND MINIMA.

Star.	No. of obs.	Dates Included.	Phase	Time.	Mag.	Observer.
		1894.		h m		
320 U Cephei	15	Nov. 19	Min.	18 40	9.2	Sperra
1623 T Camelop.		Apr. 30 to Aug. 25	Min.	July 16	<13	Dearden
3825 R Urs. Maj.	32	July 6 to Oct. 14	Max.	Aug. 6	7.5	Arnold
" " "	14	June 30 to Oct. 18	Max.	" 10	7.2	Sperra
4511 T " "	10	July 26 to Oct. 17	Max.	" 21	7.2	Sperra
4557 S " "	15	June 2 to Oct. 4	Max.	" 13	7.7	Sperra
5955 R Draconis	31	July 26 to Nov. 11	Max.	Sept.26	7.2	Arnold
7085 R T Cygni	30	Aug. 9 to Nov. 23	Min.	Oct. 7	11.5	Arnold
" " "	8	July 26 to Nov. 25	Min.	" 4	11.5	Sperra
7118 X Aquilæ	9	June 20 to Sept. 1	Max.	July 30	8.5	Parkhurst
7220 S Cygni	22	Aug. 10 to Nov. 25	Max.	Sept.12	9.5	Arnold

The foregoing observations by Messrs. Dearden, Arnold and Sperra, show good work, and it is to be hoped that they will continue.

Charts are given this month for four interesting variables.

906 R Trianguli was 10^m Dec. 3. It rises rapidly to 6^m at maximum which is predicted for the latter part of Jan., 1895.

678 U Persei is also brightening. Its period is given as "irregular" in the appendix to Chandler's Second Catalogue, but a maximum may be looked for next February. The maxima so far reported are:

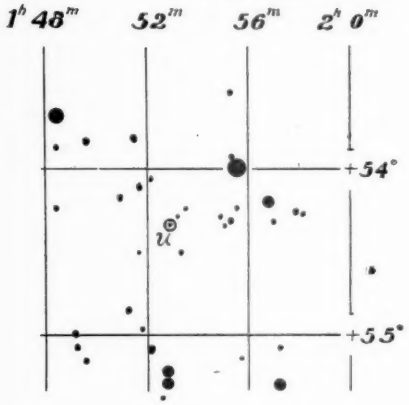
Date.	Mag.	Observer.
1891, Nov.?		Reed
1892, Aug. 21	8.2	Yendell
1893, July 15 ±	7.8	Yendell
1894, May 2	8.5	Reed
1894, May 3	7.5	J. A. Parkhurst

1894, Dec. 3, it was about 9^m.

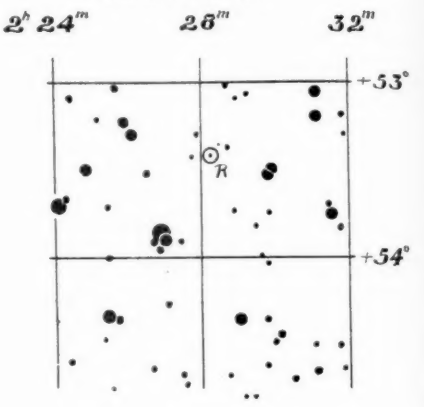
For 1805 V Orionis see POPULAR ASTRONOMY, Vol. I, page 461. It is now about 10^m and growing fainter. There is a $10^m.5$ star between V and the $9^m.5$ shown on the chart, closely south preceding V (in contact with the circle surrounding V). Observers having telescopes of 5 inches or more aperture should follow this star closely.

For 8324 V Cassiopeiæ see POPULAR ASTRONOMY, Vol. I, page 359 (where it is called B.D. + 58°,2560) and II,95. This star is now about at a minimum, but later in the winter will become prominent, and a maximum may be looked for about April, 1895.

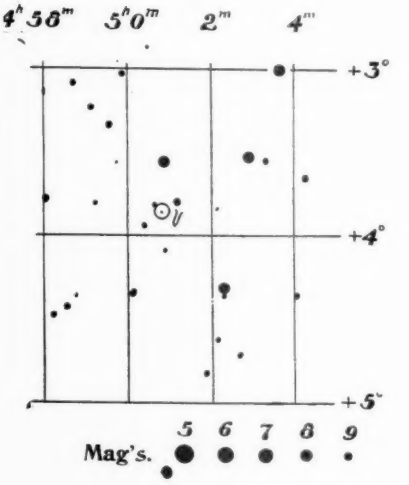
678 U Persei.



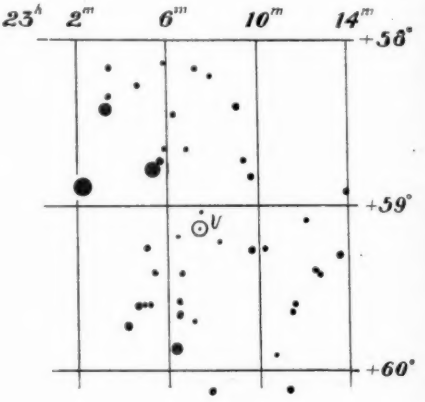
906 R Trianguli.



1805 V Orionis.



8324 V Cassiopeæ.



From Chandler's Second Catalogue and Supplement.

Star.	Place 1900. R. A.	Place 1900. Decl.	Redness	Mags. Max.	Mags. Min.	Periods.
678 U Persei	1 52 56	+54 20.1	6.4	8.2	<11	Irreg.
906 R Trianguli	2 30 59	+33 49.8	5.4	5.8	11.7	262
1805 V Orionis	5 0 47	+ 3 58.0	4.2	8.4	12<	266?
8324 V Cassiopeiæ	23 7 22	+59 8.4		8.3	12	

Marengo, Ill., 1894, Dec. 7.

POSITION OF THE EARTH'S AXIS.

ORRIN E. HARMON.

FOR POPULAR ASTRONOMY.

One of the elementary truths we learn in astronomy is that the Earth's axis is inclined to a perpendicular to the plane of the ecliptic by an angle of 23° 27′.

When, later, the student finds that the Earth's axis is in motion around the pole of the ecliptic, he may ask if this movement interferes with the inclination of the axis to the plane of the ecliptic. A moment's reflection shows him that it does not.

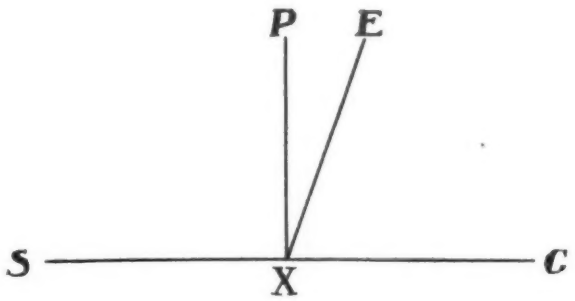


FIG. 1.

For the line EX can revolve around the line PX, which is perpendicular to SC, without changing the angle PXE. In this figure SC is supposed to be any line in the plane to which PX is perpendicular.

If through the Earth's axis we pass a plane perpendicular to the plane of the Earth's orbit, and note the relative position of this axial plane and the Earth's radius vector, we shall see that this position varies at different seasons of the year.

At the equinoxes the radius vector is perpendicular to the axial plane, while at the solstices the radius vector is parallel to the axial plane, or lies in it.

Now pass another plane through the perihelion and aphelion points of the Earth's orbit, perpendicular to the plane of the latter. Since the former plane passes through the line of the apsides, we shall call it the apsidal plane. This plane always passes through the Sun; but the axial plane above mentioned passes through the Sun only at the solstices.

Owing to the motion of the Earth's axis around the pole of the ecliptic, it and the axial plane, must have an ever-varying posi-

tion with reference to the apsidal plane. This would be true even if the apsidal plane were stationary. But the latter has a motion contrary to the motion of the axial plane. Hence the relative position of the two planes varies more rapidly than if the apsidal plane was fixed.

There must be times when the two planes coincide. Then the Earth's axis lies in the apsidal plane, and the times of the Earth's perihelion and aphelion passage are the same as the times of the solstices. At the present time we know there is a difference of ten or eleven days between the times of the Earth's arrival at the solstices and apsidal points. What causes this difference? If the axial plane were parallel to the apsidal plane, then, as above remarked, the Earth's axis would lie in the apsidal plane whenever the Earth passes perihelion and aphelion; and the solstices would fall at this time. But at the present time, the two planes are inclined to each other, and this inclination is increasing.

To determine the inclination of the Earth's axis to the apsidal plane, is a problem of some interest; and as the text books do not generally treat of the matter, I thought it might interest many readers of POPULAR ASTRONOMY. The solution is simple, and requires no mathematics beyond the elements of plane trigonometry.

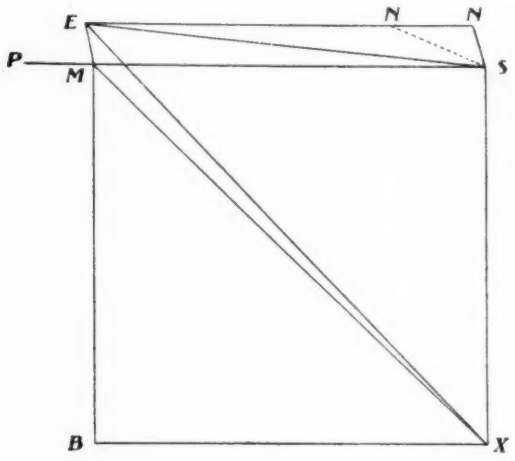


FIG. 2.

In figure 2, let SEMN be a portion of the plane of the Earth's orbit, with the Earth at E at one of the solstices. P is the perihelion point, and S the place of the Sun. Hence PS is a part of the line of the apsides. SBXM is the apsidal plane, perpendicular to SEMN. EX is the line of the Earth's axis extended, and it meets the apsidal plane at some point, X, in the line SX, the line formed by the intersection of the axial and apsidal planes. Each of these planes being perpendicular to the plane SEMN, their intersection SX is also perpendicular to the same plane. Hence the triangle ESX is right angled at S and the angle EXS is 23° 27′

or the obliquity of the ecliptic (denote by ω), SE is the Earth's radius vector (denote by r). Through EX pass a plane perpendicular to the apsidal plane SBXM. The plane so passed through EX, and the plane SEMN, each being perpendicular to SBXM, their common intersection, EM, is perpendicular to the latter plane and consequently to PS. Therefore the triangle EMSis right angled at M, as also the triangle EMX.

The angle EXM measures the inclination of the Earth's axis to the apsidal plane.

In the triangle ESX we have $EX = \frac{SE}{\sin EXS} = \frac{r}{\sin \omega}$.

In the triangle SME, EM = SE sin ESM = $r \sin a$, where a = ESM the Earth's true anomaly.

And finally, $\sin EXM = \frac{EM}{EX} = \frac{r \sin a}{\frac{r}{\sin \omega}} = \sin a \sin \omega$.

Denote the angle EXM by I and we have $\sin I = \sin a \sin \omega$, an equation which gives the inclination of the Earth's axis to the apsidal plane in terms of the obliquity of the ecliptic and the Earth's true anomaly at the solstices.

It follows that when the axial and apsidal planes are at right angles to each other, $a = 90°$ at the solstices, and the above equation becomes $\sin I = \sin \omega$, or $I = \omega$. Hence the inclination of the axis to the apsidal plane can never be greater than the obliquity of the ecliptic.

It only remains to find the value of a at the present time when the Earth is at the solstices. This is easily done by the formula $r = \frac{p}{1 + e \cos v}$. (See Young's Astronomy, page 259). From this equation we have $\cos v = \frac{p - r}{er}$, where v is the Earth's anomaly denoted in the former equation by a. Changing the term v to a, we have $\cos a = \frac{p - r}{er} = \frac{p}{er} - \frac{1}{e}$. p is the parameter of the Earth's orbit, e the eccentricity, and r the Earth's radius vector.

$p = A(1 - e^2)$ where A = semi-major axis of Earth's orbit; and when A = 1, the above expression becomes $p = 1 - e^2$. Substituting the value of p, we have $\cos a = \frac{1 - e^2}{er} - \frac{1}{e} = \frac{\frac{1}{e} - e}{r} - \frac{1}{e}$. This puts the equation in simple form for the calculation of the anomaly, as e is a constant and r is easily obtained from the *Nautical Almanac*.

I use the value of e at .01677, giving $\frac{1}{e} = 59.630292$, and

$$\frac{1}{e} - e = 59.613522.$$

In taking the value of r, it is a good plan to find it for each of the solstices, June 21 and December 21, so as to compare figures in the resulting value of a. The values of a found at these times should be supplements of each other. Using the ephemeris for 1894, I obtain for June 21st, $a = 168°$; and for December 21, $a = 12° 29'$.

This discrepancy of 29′, I think can be accounted for, 1st, by inexact calculation resulting from interminal decimals; 2d, by the value of e above given not being exactly the same as that used by the computers of the ephemeris.

However, the difference is not large enough to interfere with our reaching an approximate result in this calculation.

In the formula $\sin I = \sin a \sin \omega$, if we take a at 168°, I becomes 4° 45′; and when a is taken at 12° 29′, I becomes 4° 56′.

So we may safely say that I lies quite near 4° 50′; and this is the inclination of the Earth's axis to the apsidal plane at the present time.

We may now inquire when the axial and apsidal planes were parallel to each other; or when the times of the Earth's passing the solstitial points coincided with the times of passing the apsidal points.

The perihelion and vernal equinox separate from each other by 62″ per annum. The relative movement between the perihelion and the solstices will, of course, be the same.

As the Earth reaches a solstitial point a few days before it reaches an apsidal point, and since the perihelion moves forward while the solstitial points move backward, it follows that the solstitial and apsidal points on the ecliptic were the same but a few centuries ago. According to Loomis, the longitude of the perihelion, in 1864, was 100° 16′. Then the perihelion was 10° 16′ from the summer solstice. At the rate of 62″ per annum, it requires 596 years for the perihelion to move 10° 16′ in longitude either from an equinox or solstice. This brings us to the year A. D. 1268 when the apsidal and solstitial points coincided.

They are together every 10450 years, or twice during the period required for the perihelion to pass from an equinox or solstice, to the same point again. The same is true of the equinoctial and apsidal points. When the latter are together, the axial and apsidal planes are at right angles to each other; or a is 90° at the time of the solstices. Then the inclination of the Earth's axis to the apsidal plane is equal to the obliquity of the ecliptic as above stated.

In considering the motion of the Earth's axis, two periods of time must be kept in view: one of 25,800 years, and the other of 20,900 years.

In the former period, the axis describes its grand circuit around the pole of the ecliptic; in the latter, perihelion moves from an equinox or solstice to the same equinox or solstice again.

In tracing the first cycle of years we map out in the heavens the grand circle of stars that wear the glory of "The North Star."

In the second cycle we mark the time when the Earth's axis is swaying its beautiful variations with the great standard plane of the apsides.

In passing through these variations from zero to its greatest inclination, the Earth's axis requires 5225 years, or one-fourth of the period required for a tropical revolution of the perihelion.

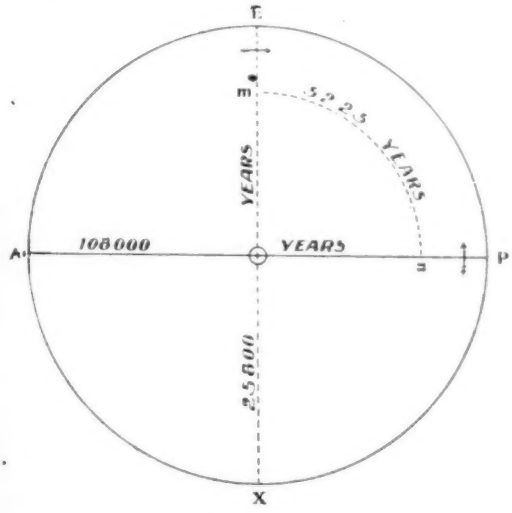


FIG. 3.

The relative motions of the apsidal points, and of the equinoctial or solstitial points, are shown in Figure 3. AP represents the line of the apsides, which moving forward at the rate of 12″ per annum requires 108,000 years to make a sidereal revolution. EX represents the line of the solstices (or equally well the line of the equinoxes) which moving backward at the rate of 50″ per annum requires 25,800 years to make a sidereal revolution. In this figure AEPX represents the ecliptic; and supposing the axial plane to be at right angles to the apsidal plane, the solstitial line EX will be at right angles to the line of apsides, AP, as shown in the figure. Now if the two lines are at right angles to each other, they will meet in 5225 years. Or this is the time value of the quadrant EOP as noted on the arc *mn*. Then if the apsidal and solstitial lines were together in A. D. 1263, they were at right angles to each other about B. C. 3957.

It remains to notice the effect the varying positions of the axial and apsidal planes exert on the comparative length of the seasons.

In considering this, the elliptical form of the Earth's orbit must be taken into account.

In figure 4, AEPX represents the Earth's orbit, only the eccentricity is much greater in the figure than in the real orbit of the Earth. But the figure will serve our purpose.

AP is the line of the apsides, *ex* the line of solstices, and VN the line of equinoxes. The Earth passes the apsidal, solst tial and equinoctial points as shown in the figure.

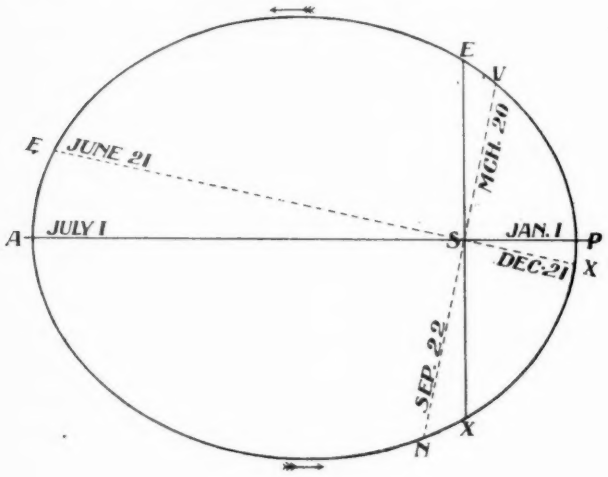


FIG. 4.

It is clear that to move from V to N through A, requires a longer time than to move from N to V through P. This difference of time, as every intelligent person knows, is about seven days, and is due to the Earth's slower motion in passing aphelion. But in A. D. 1268, the line *ex* coincided with AP, and *vn* with EX. Then, since the Earth moves from E to A in the same time it moves from A to X, the time between the vernal equinox and summer solstice was equal to the time between the summer solstice and the autumnal equinox. In other words, the spring and summer were equal. By similar reasoning the autumn and winter were equal, but each shorter than the spring or summer.

In B. C. 3957, VN coincided with AP, and *ex* with XE. Then the winter and spring were equal and each longer than the summer and autumn which were also equal.

Briefly, then, we may say, that when the axial plane is parallel with the apsidal plane, the solstices equally divided the year; but when the axial plane is at right angles to the apsidal plane, the equinoxes equally divide the year.

CHEHALIS, Lewis County, Wash.

ALMANACS.

R. W. McFARLAND.

I.

FOR POPULAR ASTRONOMY.

It has been suggested that a brief article or two on this subject might be of interest to some of the readers of POPULAR ASTRONOMY. A treatise adequate to a thorough elucidation of the topic, would, by its extent, be unsuitable for the pages of this journal. Wherefore, only a few points will be treated of, although the subject is of real historic interest. The larger subject of chronology underlies and comprehends the one now in hand; for some sort of calendar has been in use from the earliest period of recorded history.

If astronomy was man's first science, then, of necessity, the almanac is not a modern invention. From the remotest times it was known in Egypt that the year consisted of very nearly 365¼ days. Very near the beginning of the book of Genesis the *year* is mentioned over and over again; and in the seventh chapter there is a more specific statement, viz., "In the second month, the seventeenth day of the month." . . . "And the waters prevailed upon the Earth one hundred and fifty days." . . . "And the ark rested, in the seventh month, on the seventeenth day of the month." . . . Here, then, is a calendar showing an interval of one hundred and fifty days, from the seventeenth of the second month to the seventeenth of the seventh month, *i. e.*, five months of thirty days each. Such evidently was the understanding of the author of that account.

A civilization without a calendar is what the world has not yet seen, and is not likely to see. Learned men have long puzzled themselves and others by their attempts to explain the calendar of the Mexicans and of the Peruvians, whose civilization was of a very moderate type. Classical readers will call to mind something of the Greek calendar; and many of the readers of POPULAR ASTRONOMY may know that the *Golden Number* or *Lunar Cycle* was the invention or discovery of Meton, a Greek astronomer of the fifth century before Christ. Our own calendar is substantially that made by Julius Caesar nearly half a century B. C.; and *that* was only a sort of stereotyping of the ancient Roman Calendar. Only slight modifications have been made in nineteen centuries and a half.

The festivals of the heathen gods constituted a prime ground for the priestly care of the calendar; and the almanacs of modern

times have not days enough for the saints alone, unless when grouped together, as in "All-Saints' Day." The modern celebration of this festival has sadly deteriorated from saintly austerity.

The invention of printing and the benevolence or the greed of patent medicine makers, have made it possible for everybody to take an almanac "free." Whereas, before the invention whether of printing or of patent medicine, any form of almanac was necessarily restricted to a very limited circulation. Some reference to the Roman calendar may be found in the 46th chapter of the 9th book of Livy,—to a period three centuries B. C.

The Christian feast of Easter, after long and bitter dissension, was finally fixed by the council which met at Nicaea in the year 325 A. D. For the origin and the meaning of the word *almanac*, the reader is referred to any standard dictionary. It is here used in the popular sense. The British Museum and the libraries of Oxford and Cambridge are said to have manuscript almanacs reaching as far back as the middle ages. One ascribed to Roger Bacon relates to 1292; that of Somers to 1380. The earliest in the Museum is said to bear the date 1431. The first printed almanacs were made in Germany, for the year 1457. The first in England was for 1497. In the reign of Elizabeth of England, (1558-1602) two persons of "The Company of Stationers" had the exclusive privilege of selling almanacs. Her successor, James I, extended the privilege to the two universities, and this monopoly lasted until the latter part of the last century. A bookseller named Carnan printed and sold almanacs contrary to the "statute made and provided in such cases," and was sent to prison several times for his disregard of the monopoly. In 1775 the monopoly terminated.

It is known to most readers of this day, that in the middle ages, astronomy was studied chiefly as a guide to astrology; and astrology was studied for the purpose of forecasting the fate of men and of nations. To each of the planets and to the Moon certain influences were ascribed, and when two or more planets "pooled their issues," the result might be beneficent or baleful to those concerned. It is in this age a rich treat to read some of the literature of this astronomy run mad. It was then often a serious matter to many,—not from the truth of the predictions, but from the general belief in the subject. Almanacs three centuries ago were devoted to prediction as their chief and legitimate business. These predictions related to governments, and to kings and princes especially. Here is an announcement for 1583:

"Prognosticacyon of Mayster John Thybault, medycyner and

astronomer of the Emperyall Majestie, of the yere of our Lorde God, MCCCCCLXXXIIJ, comprehending the IIIJ partes of this yere, and of the influence of the mone, of peas and warre, and of the sykenesses of this yere, with constellacions of them that be under the VIJ planettes, and the revolucions of kings and princes, and of the eclipses and comets."

In 1579, king Henry III of France forbade almanac makers to indulge in "prognosticacyons." Of course by the "untutored mind" these predictions were taken seriously,—even if sometimes they may not have directly brought on the fulfilment of the thing prophesied. There seems to be a natural inclination in the human mind to be superstitious in regard to the heavenly bodies. All literature is full of it. Belief in the efficacy of the Moon in nearly all the affairs of life, is wide-spread and deep-seated in the majority of the denizens of this republic. One not posted on this subject would be surprised to find among his acquaintances the strength of the belief in old astrology.

Shakespeare says:

> "When beggars die, there are no comets seen."

An almanac called "*Poor Robin*" was continuously published from 1663 to 1828. Partridge's *Mercurius Cœlestis* was begun in 1681. Its accumulation of predictions in its successive years would put to shame any of the old prophets. Pope in the 5th canto of *The Rape of the Lock*, says,

> " . . . A sudden star—it shot through liquid air . . .
> This Partridge soon shall view in cloudless skies,
> When next he looks through Galileo's eyes."

And Swift in 1708, under the *nom de plume* of *Bickerstaft*, made a long and specific prediction of the death of Partridge himself, and modeled it after Partridge's own style, to the infinite amusement of all except the subject of the prophecy.

In a certain case, so late as 1758, there was in a court of Justice, in England, an appeal to the evidence given by astrology.

The first almanac printed in this country, was that of Wm. Bradford, of Philadelphia, in 1687. Franklin's *Poor Richard's Almanac* was begun in 1732 and continued for 25 years. It was full, not of predictions, but of proverbs and wise sayings gathered from the wisdom and experience of all ages and nations.

PLANET NOTES FOR FEBRUARY.

H. C. WILSON.

Mercury will be at greatest elongation, east 18° 11′ from the Sun, at noon Feb. 9. During the first half of the month the planet will be visible to the naked eye for an hour or more after sunset. He will be in the constellation Aquarius where there are no very bright stars to be mistaken for him. *Venus*, however, will be in the same region of sky. The two planets will be in conjunction on the morning of Feb. 1. Mercury will then be 0° 35′, or about 1 diameter of the Moon north of Venus. Both planets will move eastward, Mercury at first a little faster than Venus, then slower until on Feb. 10, they will again be in conjunction Mercury will move northward more rapidly than Venus, so that on the last mentioned date the former will be 2° 38′, or about 5 diameters of the Moon, north of the latter. It will be interesting to compare the phases of the two planets at this time. That of Venus is almost full, since she is on the farther side of her orbit, and will decrease slowly. That of Mercury will be gibbous at the first of the month and will rapidly decrease to half full Feb. 9 and crescent after that. After Feb. 10 Mercury will move rapidly around between us and the Sun, coming to inferior conjunction at 1 A. M. Feb. 25. The new Moon will pass Mercury on the morning of Feb. 24 and Venus on the morning of Feb. 26.

Mars will be pretty low in the west to be observed well in the evening during February, but some good views may be obtained in the twilight, just after sunset. As indicated on the Poole Bros. map in this number of POPULAR ASTRONOMY the planet will move eastward from Aries into Taurus. During the last days of the month Mars will be just south of the Pleiades. He will be at quadrature, 90° east from the Sun, Feb. 5. His phase is now quite perceptibly gibbous. We have not been able to see any definite signs of the return of the south polar snow-cap since October, although the seeing has been so invariably poor this winter that it has been impossible to see any of the finer details of the planet's surface markings. The Moon will be in conjunction with Mars Feb. 2 at $10^h\ 49^m$ P. M.

Jupiter during February will make the turn of the loop in his apparent path, being nearly stationary among the stars. He will be in good position for observation from 5^h to 9^h P. M. Inadvertently, last month, we omitted the page diagram, showing the relative positions of the satellites and the planet, which we ourselves find very convenient in identifying the satellites at any time. Among the configurations of the satellites for this month we notice two that are especially interesting:—that on the 20th when the four will apparently form two double stars to the right of the planet, and that on the 28th when the 1st, 2d and 4th will be close together and all moving in the same direction.

Saturn will make the turn of the east end of the loop in his apparent path and begin retrograde motion during this month. This planet is to be observed only in the morning hours although it rises before midnight.

Uranus is also rounding the east end of his loop and will be almost stationary in Libra during the month.

Neptune may be observed in the early evening, a little south-west from the star ι Tauri. The planet can be seen with a small telescope, but as it looks exactly like a small star it will be necessary to look it up by using the right ascension and declination, or if the telescope is not provided with circles, to make a careful chart of all the stars in the vicinity on two or three nights and note the one which moves.

Planet Tables for February.

[The times given are local time for Northfield. To obtain Standard Times for Places in approximately the same latitude, add the difference between Standard and Local Time if west of the Standard Meridian or subtract if east].

Date.	R. A.	Decl.	Rises.	Transits.	Sets.
	h m	° ′	h m	h m	h m
MERCURY.					
Feb. 5	22 24.2	− 10 10	7 59 A. M.	1 21.6 P. M.	6 44 P. M.
15	22 51.3	− 4 45	7 24 "	1 09.2 "	6 54 "
25	22 25.6	− 5 52	6 24 "	12 04.1 "	5 44 "
VENUS.					
Feb. 5	22 21.0	− 11 54	8 03 A. M.	1 18.5 P. M.	6 34 P. M.
15	23 07.7	− 7 07	7 51 "	1 25.8 "	7 01 "
25	23 53.3	− 2 02	7 37 "	1 32.0 "	7 27 "
MARS.					
Feb. 5	2 55.8	+ 18 16	10 34 A. M.	5 52.9 P. M.	1 12 A. M.
15	3 17.4	+ 19 46	10 09 "	5 35.1 "	1 02 "
25	3 40.2	+ 21 08	9 35 "	5 18.4 "	12 51 "
JUPITER.					
Feb. 5	5 45.2	+ 23 18	12 57 P. M.	8 41.2 P. M.	4 25 A. M.
15	5 43.8	+ 23 19	12 16 "	8 00.6 "	3 45 "
25	5 43.9	+ 23 20	11 37 A. M.	7 21.3 "	3 06 "
SATURN.					
Feb. 5	14 22.7	− 11 32	12 00 Midn.	5 17.3 A. M.	10 35 A. M.
15	14 23.0	− 11 31	11 21 P. M.	4 48.3 "	9 56 "
25	14 22.7	− 11 27	10 41 "	3 58.6 "	9 16 "
URANUS.					
Feb. 5	15 09.8	− 17 22	1 12 A. M.	6 04.3 A. M.	10 56 A. M.
15	15 10.2	− 17 24	12 29 "	5 21.4 "	10 14 "
25	15 10.3	− 17 24	11 53 P. M.	4 45.2 "	9 37 "
NEPTUNE.					
Feb. 5	4 47.4	+ 20 54	12 12 P. M.	7 43.6 P. M.	3 16 A. M.
15	4 47.1	+ 20 54	11 32 A. M.	7 04.0 "	2 36 "
25	4 47.1	+ 20 55	10 53 "	6 24.6 "	1 57 "
THE SUN.					
Feb. 5	21 16.8	− 15 50	7 14 A. M.	12 14.2 P. M.	5 14 P. M.
15	21 56.3	− 12 34	7 00 "	12 14.3 "	5 28 "
25	22 34.6	− 8 59	6 44 "	12 13.2 "	5 42 "

Occultations Visible at Washington.

Date 1894	Star's Name.	Magnitude.	IMMERSION. Washington M. T.	IMMERSION. Angle from N p't.	EMERSION. Washington M. T.	EMERSION. Angle from N p't.	Duration.
			h m	°	h m	°	h m
Feb. 3	*g* Pleiadum	6.3	9 10	126	10 00	208	0 50
3	19 Tauri	5.0	9 16	87	10 30	248	1 14
3	21 Tauri	7.0	9 41	76	10 54	262	1 13
3	20 Tauri	5.0	9 42	118	10 38	219	0 56
3	22 Tauri	7.0	9 45	84	10 57	254	1 12
6	47 Geminorum	6.0	15 51	38	16 10	355	0 19
16	r Scorpii	3.2	18 51	132	20 11	254	1 20

Phases and Aspects of the Moon.

		Central Time. h	m
First Quarter	Feb.	2	6 16 P. M.
Perigee		9	7 12 A. M.
Full Moon		9	11 23 "
Last Quarter		16	7 09 "
Apogee		22	12 48 P. M.
New Moon		24	10 44 A. M.

Jupiter's Satellites for December.

Phases of the Eclipses of the Satellites for an Inverting Telescope.

I. r

III. d r

II. r

IV. d r

Configurations at 9h for an Inverting Telescope.

Day.	West.	East.	e
1	·4 3·	○ 1·	·2●
2	·3	○ ·4 2·	·1●
3	·3 2· 1·	○ ·4	
4	·2 ·3	○ ·1 4·	
5	1·	○ ·2 ·3 ·4	
6		○ 2· 1· 3· 4·	
7	2· ·1	○ 3· 4·	
8	3·	○ 1· 4.	·2●
9	3· ·1	○ 2· 4·	
10	·3 2· 1·	○ 4·	
11	4. ·3	○ ·1	
12	·4 1·	○ ·2 ·3	
13	4·	○ 2· ·3	
14	·4 2· 1·	○ 3·	
15	·4 3·	○ 1·	
16	·4 3· ·1	○ ·2	
17	○1· 3·	2· ○	
18	.2 3·	○ ·1	
19	1·	○ 2· ·3	
20		○ 3·	
21	2· 1·	○ 3· 4·	
22	○3· ·2	○ 1· 4·	
23	3· ·1	○ ·2 4·	
24	○2· ·3	○ 1· 4·	
25	·2 ·3	○ 4·	·1●
26	1·	○ ·2 3 4·	
27	4·	○ .1 2· 3·	
28	4· 2· 1.	○ 3·	

Phenomena of Jupiter's Satellites.

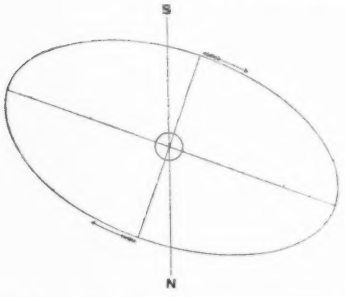
Central Time.

Feb.	1	12 16	P. M.	III	Tr.	Eg.
		1 08	"	III	Sh.	In.
		4 05	"	III	Sh.	Eg.
		6 08	"	II	*Oc.	Dis.
		10 25	"	I	*Tr.	In.
		10 34	"	II	*Ec.	Re.
		11 21	"	I	*Sh.	In.
	2	12 42	A. M.	I	*Tr.	Eg.
		1 38	"	I	*Sh.	Eg.
		7 35	P. M.	I	*Oc.	Dis.
		10 47	"	I	*Ec.	Re.
	3	1 25	A. M.	IV	*Ec.	Dis.
		2 37	"	IV	*Ec.	Re.
		12 31	P. M.	II	Tr.	In.
		2 24	"	II	Sh.	In.
		3 08	"	II	Tr.	Eg.
		4 52	"	I	*Tr.	In.
		5 04	"	II	*Sh.	Eg.
		5 50	"	I	*Sh.	In.
		7 08	"	I	*Tr.	Eg.
		8 07	"	I	*Sh.	Eg.
	4	2 03	"	I	Oc.	Dis.
		5 16	"	I	*Ec.	Re.
		11 02	"	III	*Oc.	Dis.
	5	1 53	A. M.	III	*Oc.	Re.
		3 04	"	III	Ec.	Dis.
		5 52	"	III	Ec.	Re.
		7 19	"	II	Oc.	Dis.
		11 19	"	I	Tr.	In.
		11 52	"	II	Ec.	Re.
		12 19	P. M.	I	Sh.	In.
		1 36	"	I	Tr.	Eg.
		2 36	"	I	Sh.	Eg.
	6	8 30	A. M.	I	Oc.	Dis.
		11 45	"	I	Ec.	Re.
	7	1 44	"	II	*Tr.	In.
		3 43	"	II	Sh.	In.
		4 21	"	II	Tr.	Eg.
		5 46	"	I	Tr.	In.
		6 23	"	II	Sh.	Eg.
		6 47	"	I	Sh.	In.
		8 03	"	I	Tr.	Eg.
		9 04	"	I	Sh.	Eg.
	8	2 57	"	I	Oc	Dis.
		6 14	"	I	Ec.	Re.
		12 59	P. M.	III	Tr.	In.
		3 49	"	III	Tr.	Eg.
		5 08	"	III	*Sh.	In.
		8 06	"	III	*Sh.	Eg.
		8 30	"	II	*Oc.	Dis.
	9	12 14	A. M.	I	*Tr.	In.
		1 10	"	II	*Ec.	Re.
		1 16	"	I	*Sh.	In.
		2 30	"	I	*Tr.	Eg.
		3 33	"	I	Sh.	Eg.
		9 25	P. M.	I	*Oc.	Dis.
	10	12 43	A. M.	I	*Ec.	Re.
		2 57	P. M.	II	Tr.	In.
		5 02	"	II	*Sh.	In.
		5 34	"	II	*Tr.	Eg.
		6 41	"	I	*Tr.	In.
		7 42	"	II	*Sh.	Eg.
Feb.	10	7 45	P. M.	I	*Sh.	In.
		8 57	"	I	*Tr.	Eg.
		10 02	"	I	*Sh.	Eg.
	11	10 31	A. M.	IV	Sh.	In.
		12 05	P. M.	IV	Sh.	Eg.
		3 52	"	I	Oc.	Dis.
		7 12	"	I	*Ec.	Re.
	12	2 38	A. M.	III	Oc.	Dis.
		5 29	"	III	Oc.	Re.
		7 04	"	III	Ec.	Dis.
		9 42	"	II	Oc.	Dis.
		9 54	"	III	Ec.	Re.
		1 08	P. M.	I	Tr.	In.
		2 13	"	I	Sh.	In.
		2 27	"	II	Ec.	Re.
		3 24	"	I	Tr.	Eg.
		4 30	"	I	Sh.	Eg.
	13	10 20	A. M.	I	Oc.	Dis.
		1 41	P. M.	I	Ec.	Re.
	14	4 10	A. M.	II	Tr.	In.
		6 21	"	II	Sh.	In.
		6 48	"	II	Tr.	Eg.
		7 35	"	I	Tr.	In.
		8 42	"	I	Sh.	In.
		9 01	"	II	Sh.	Eg.
		9 52	"	I	Tr.	Eg.
		10 59	"	I	Sh.	Eg.
	15	4 47	"	I	Oc.	Dis.
		8 10	"	I	Ec.	Re.
		4 37	P. M.	III	Tr.	In.
		7 28	"	III	*Tr.	Eg.
		9 08	"	III	*Sh.	In.
		10 55	"	II	*Oc.	Dis.
	16	12 08	A. M.	III	*Sh.	Eg.
		2 03	"	I	*Tr.	In.
		3 11	"	I	Sh.	In.
		3 45	"	II	Ec.	Re.
		4 19	"	I	Tr.	Eg.
		5 28	"	I	Sh.	Eg.
		11 15	P. M.	I	*Oc.	Dis.
	17	2 39	A. M.	I	Ec.	Re.
		5 25	P. M.	II	*Tr.	In.
		7 40	"	II	*Sh.	In.
		8 02	"	II	*Tr.	Eg.
		8 31	"	I	*Tr.	In.
		9 40	"	I	*Sh.	In.
		10 20	"	II	*Sh.	Eg.
		10 47	"	I	*Tr.	Eg.
		11 57	"	I	*Sh.	Eg.
	18	5 43	"	I	*Oc.	Dis.
		9 08	"	I	*Ec.	Re.
	19	6 18	A. M.	III	Oc.	Dis.
		8 36	"	IV	Oc.	Dis.
		9 10	"	III	Oc.	Re.
		9 12	"	IV	Oc.	Re.
		11 04	"	III	Ec.	Dis.
		12 08	P. M.	II	Oc.	Dis.
		1 55	"	III	Ec.	Re.
		2 58	"	I	Tr.	In.
		4 08	"	I	Sh.	In.
		5 03	"	II	*Ec.	Re.
		5 15	"	I	*Tr.	Eg.

Feb.	19	6	26	P. M.	I	*Sh.	Eg.	Feb.	24	11	35	P. M.	I *Sh. In.
		7	23	"	IV	*Ec.	Dis.		25	12	38	A. M.	I *Tr. Eg.
		8	59	"	IV	*Ec.	Re.			12	59	"	II *Sh. Eg.
	20	12	10	"	I	Oc.	Dis.			1	52	"	I Sh. Eg.
		3	36	"	I	Ec.	Re.			7	34	P. M.	I *Oc. Dis.
	21	6	40	A. M.	II	Tr.	In.			11	03	"	I *Ec. Re.
		8	59	"	II	Sh.	In.		26	11	03	A. M.	III Oc. Dis.
		9	17	"	II	Tr.	Eg.			12	56	P. M.	III Oc. Re.
		9	26	"	I	Tr.	In.			2	35	"	II Oc. Dis.
		10	37	"	I	Sh.	In.			3	04	"	III Ec. Dis.
		11	40	"	II	Sh.	Eg.			4	49	"	I Tr. In.
		11	42	"	I	Tr.	Eg.			5	56	"	III *Ec. Re.
		12	54	"	I	Sh.	Eg.			6	03	"	I *Sh. In.
	22	6	38	A. M.	I	Oc.	Dis.			7	06	"	I *Tr. Eg.
		10	05	"	I	Ec.	Re.			7	38	"	II *Ec. Re.
		8	19	P. M.	III	*Tr.	In.			8	21	"	I *Sh. Eg.
		11	12	"	III	*Tr.	Eg.		27	2	02	"	I Oc. Dis.
	23	1	08	A. M.	III	*Sh.	In.			5	06	"	IV *Tr. In.
		1	21	"	II	*Oc	Dis.			5	32	"	I *Ec. Re.
		3	54	"	I	Tr.	In.			6	05	"	IV *Tr. Eg.
		4	09	"	III	Sh.	Eg.		28	4	29	A. M.	IV Sh. In.
		5	06	"	I	Sh.	In.			6	21	"	IV Sh. Eg.
		6	10	"	I	Tr.	Eg.			9	11	"	II Tr. In.
		6	20	"	II	Ec.	Re.			11	18	"	I Tr. In.
		7	23	"	I	Sh.	Eg.			11	37	"	II Sh. In.
	24	1	06	A. M.	I	Oc.	Dis.			11	49	"	II Tr. Eg.
		4	34	"	I	Ec.	Re.			12	32	P. M.	I Sh. In.
		7	55	P. M.	II	*Tr.	In.			1	34	"	I Tr. Eg.
		10	18	"	II	*Sh.	In.			2	18	"	II Sh. Eg.
		10	21	"	I	*Tr.	In.			2	49	"	I Sh. Eg.
		10	33	"	II	*Tr.	Eg.		29	8	31	A. M.	I Oc. Dis.

NOTE.—In., denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance; Ec., eclipse. Oc., denotes occultation; Tr., transit of the satellite; Sh. transit of the shadow; * Visible at Washington.

The Satellite of Neptune.



APPARENT ORBIT OF THE SATELLITE OF NEPTUNE, AS SEEN IN AN INVERTING TELESCOPE.

CENTRAL TIMES OF GREATEST ELONGATIONS.

Period $5^d\ 21^h.045$.

East.		West.	
Feb. 3	12.5 A. M.	Feb. 5	11.1 P. M.
8	9.6 P. M.	11	8.2 "
14	6.7 "	17	5.2 "
20	3.8 "	23	2.3 "
26	12.9 "	Mar. 1	11.4 A. M.

In the diagram the central circle represents the planet and is drawn to the same scale as the orbit of the satellite.

Transit of Mercury, Nov. 10-11, 1894.—The sky was cloudless, the air clear and the limb of the Sun remarkably steady at ingress.

The first exterior contact was well seen, the limb of Sun and planet being sharply defined. I failed to see the body of the planet, or any light around at

first contact, but after second contact (first interior) a narrow ring of dim or light grey surrounded the planet like a halo or corona during the above transit. The body of the planet was intensely black, at times blue-black, and exquisitely defined, blacker, I thought, than the *umbræ* of the spots on the Sun.

I did not see the speck of light on the disc of Mercury, observed by some at other transits.

At egress, the limb of the Sun was considerably agitated and wavy, and the last two contacts were not as well seen as the first two.

There was no appearance of "black drop" or apparent elongation of planet, at either interior contact.

The observed time of contacts was as follows:

First	contact	10^h	57^m	15^s	A. M.,	E. S. T.
Second	"	10	59	08	"	"
Third	"	4	11	02	P. M.	"
Fourth	"	4	12	55	"	"

Calculated time for Wilmington, N. C.

First	contact	10^h	55^m	$45^s.88$	A. M., E. S. T.
Fourth	"	4	12	03 .61	P. M. "

Instrument, refractor (Clark) 5-in. power 105. E. S. MARTIN.
Wilmington, N. C.

The morning of Saturday opened cloudy with light snow falling and very windy, but about 9 A. M. the clouds partly dispersed and for about 15 minutes before 1st contact the Sun was nearly clear, but the windy atmosphere was filled with flying particles of frost, so that the Sun's limb appeared more like the undulating waves of a stormy ocean. It was impossible to observe the I contact and the II contact was not much better, but I recorded the moment at which I was sure I could detect a ring of light between the planet and the Sun's limb, but the atmospheric conditions were so bad that this phase is at least 2 minutes late and hence of no value.

About noon the air was quite steady and the image of the planet was sharp and well defined appearing to my eye as a uniformly jet black disc. III contact was quite accurately observed and the time recorded will not be over 1 or 2 seconds in error; there was a slight waviness of the Sun's limb which momentarily increased as the IV contact took place so that the time recorded is somewhat late.

Telescope used, 3-inch Jena objective by Brashear, with diagonal eye-piece, magnifying power 85, used dark green and purple shade glasses. Time from excellent watch compared with noon telegraphic signals on 9th and 10th, and times of contacts recorded by Professor Crosby, principal of High School.

Following are the times of phases:

CENTRAL STANDARD TIME.

I.	Contact, could not observe, owing to atmospheric conditions.			
II.	Contact	9^h	59^m	45^s This is fully 2^m late and of little value.
III.	Contact	3	11	30 Quite accurately observed.
IV.	Contact	3	13	03 Atmosphere unsteady, late.

Lat. 42° 40′ N.
Long. 95° 15′ W. } Approx.

DAVID E. HADDEN.

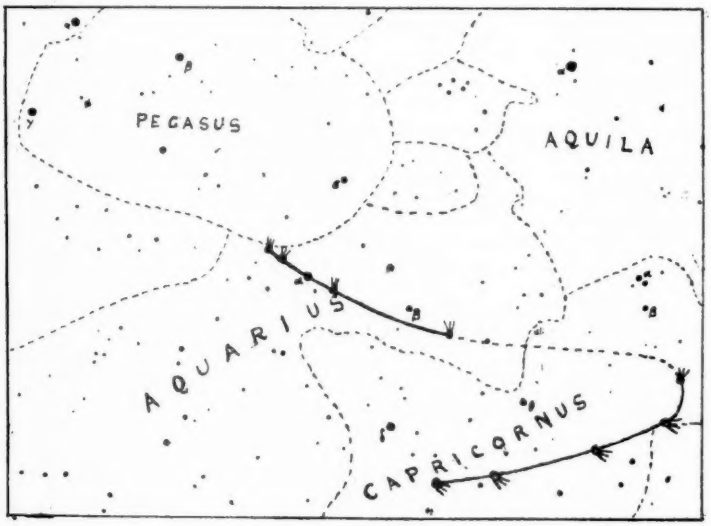
Alta, Iowa, Nov. 13, 1894.

COMET NOTES.

Comet *e* 1894.—(*Edward Swift, Nov. 20.*)—This is a very faint comet and is growing fainter. It will probably not be visible in January even in the large telescopes. The inclination of its orbit to the ecliptic is very small, which leads computers to expect that it will turn out to be a periodic comet. Very few observations of this comet have been reported as yet. As seen with the 16-inch telescope at Northfield on the night of Dec. 18 it had a slight condensation about 30″ in diameter and an exceedingly faint tail 3′ long.

European observers have called attention to the fact that the elements of this comet resemble closely those of the lost comet of De Vico, 1844, I. If so it is important that as many observations as possible be obtained with the larger telescopes. It has been observed at Northfield on five dates during December but it is doubtful whether it can be seen in January.

Encke's Comet.—When discovered on Nov. 1 this comet was very faint, almost at the limit of vision with the large telescope with which it was discovered. According to the ephemeris which we give below, its theoretical brightness will be very much greater in January. It is quite probable therefore that those with small telescopes will be able to see the comet in spite of its increasingly unfavorable position with reference to the twilight.



PATH OF ENCKE'S COMET.

The accompanying cut gives the apparent course of the comet among the stars from Jan. 1 to March 20. It runs from the southern boundary of Pegasus,

south-west through Aquarius turning in Capricornus and after that running eastward. In the dotted portion of the path the comet will be passing between the Earth and Sun and will therefore be invisible. The points marked with the sign of a comet indicate the comet's position on the dates Jan. 1, 10, 20 and 28, Feb. 10, 20, 28, March 10 and 20 During January the comet will be visible in the evening between 6^h and 8^h P. M., and in February it will be visible toward the south-east in the morning.

Ephemeris of Encke's Comet.

Berlin Midnight.		R. A. h	m	s		Decl. °	′	log *r.*	log R.	Brightness.
Jan.	1	22	13	52	+	3	04	9.9401	9.9186	4.76
	2		13	32		2	55			
	3		13	10		2	46			
	4		12	44		2	36			
	5		12	16		2	26	9.9036	9.9044	6.01
	6		11	44		2	15			
	7		11	09		2	04			
	8		10	28		1	51			
	9		09	42		1	38	9.8629	9.8871	7.85
	10		08	51		1	24			
	11		07	52		1	08			
	12		01	46		0	51			
	13		05	31		0	32	9.8171	9.8667	10.65
	14		04	07	+	0	12			
	15		02	33	−	0	11			
	16	22	00	46		0	35			
	17	21	58	47		1	02	9.7657	9.8436	15.01
	18		56	33		1	32			
	19		54	04		2	05			
	20		51	17		2	41			
	21		48	11		3	20	9.7084	9.8193	21.86
	22		44	45		4	04			
	23		40	57		4	52			
	24		36	47		5	44			
	25		32	13		6	41	9.6468	9.7988	31.90
	26		27	16		7	42			
	27		21	57		8	47			
	28		26	18	−	9	57			
		Too Near the Sun for Observation.								
Feb.	9	20	18	04	−	22	50	9.5558	9.8907	31.71
	10		16	49		23	24			
	11		16	12		23	52			
	12		16	07		24	16			
	13		16	30		24	35	9.6076	9.9451	19.48
	14		17	18		24	51			
	15		18	27		25	04			
	16		19	53		25	13			
	17		21	33		25	20	9.6693	9.9926	11.78
	18		23	25		25	26			
	19		25	26		25	30			
	20		27	34		25	31			
	21		29	49		25	32	9.7297	0.0323	7.43
	22		32	07		25	31			
	23		34	29		25	29			
	24		36	53		25	26			
	25		39	19		25	23	9.7850	0.0651	4.95
	26		41	46		25	19			
	27		44	13		25	14			
	28	20	46	41	−	25	09			

Encke's Comet.—This comet was so recently discovered that I was under the impression that it must be still very faint, but on the evening of the 27th of November, using the comet seeker, Edward detected a large, bright comet which, for a few minutes, he thought was a new one, but which we soon ascertained was at or very near the place which Encke's ought to occupy. We found it visible, also, in the 3½-inch finder of the 16-inch telescope.

The ephemeris published extended only to Nov. 8, and, rather strangely had not been given out at the time of the discovery of the comet.

I am very pleasantly situated here, and the number of clear nights enjoyed is in striking contrast to my former experience in Rochester, N. Y. Since April 20, the date of my arrival here, the number of cloudy nights has averaged about three per month.

The Observatory is situated about 3700 feet above the level of the Pacific Ocean which is plainly in sight, some thirty miles away, and whose breakers lapping the shore may be seen on clear days.

Fog, which very often fills the San Gabriel Valley, seldom rises to Echo Mountain on which the Observatory stands. LEWIS SWIFT.

Lowe Observatory, Echo Mountain, Cal., Dec. 5, 1894.

Observations at Lowe Observatory.—On the evening of Nov. 20, at $8^h\ 30^m$, my son and assistant, Edward D. Swift, discovered a very faint comet near Sigma Aquarii. As no nebula was recorded for that place, and as its elongation was towards the Sun, it aroused suspicion that the newly detected object might prove a comet. By the time motion was certainly ascertained, it had descended too low to secure a good position, the seeing being poor and the zodiacal light, here quite conspicuous, interfering. But the place obtained from the circle reading was, right ascension $22^h\ 18^m\ 25^s$, declination $-13^\circ\ 7'$. As our telescope is not yet in accurate adjustment it is very possible that this position is not entirely exact. Having a telegraph office within a few feet of the Observatory, immediate notification of its discovery was sent to Professor E. C. Pickering, to the Lick Observatory and to the Associated Press. From recent observations, the comet seems to be decreasing in brightness.

Because of its direction of motion being so nearly parallel to the ecliptic, the suspicion that it is a periodic was, at once, awakened. It, very probably, is another member of the Jupiter comet family though, if so, it has appeared too early to be a return of Barnard's comet for 1884.

The transit of Mercury was observed here in a cloudless sky. At the first contact the air was exceedingly steady, but not so good at the last. The planet was not seen off of the Sun, nor was any circle of light observed surrounding the planet, though both phenomena were watched for. To my own eye there seemed to be a bright central point, but no other person could see it. Just previous to the transit, our watches were set to Standard Pacific time from Mare Island, but, as our results differed much from the computed times, I was fearful a mistake had somehow occurred. The following is the record of the event:

First	Contact	7^h	57^m	10^s
Second	"	7	58	36
Third	"	1	11	26
Fourth	"	1	13	10

Pacific Standard time 8^h slow of Greenwich. LEWIS SWIFT.

GENERAL NOTES.

Our series of excellent star maps taken from the Poole Brother's Planisphere closes with this number. But for the generosity of the above named publishers we could not have afforded such a treat for our readers.

The full contents of original articles in this number have given small space for notes and practical suggestions. If our subscription list were longer we could increase the size of this journal and keep its price at the present low figure.

Eclipses in 1895.—There will be five eclipses during the year: three of the Sun and two of the Moon.

1. The first will be a total eclipse of the Moon, March 10, visible generally throughout North and South America and the western portions of Europe and Africa. The beginning will be visible in the western portion of Asia and the end in the Pacific Ocean. The middle of the eclipse will be $9^h\ 39^m$ P. M. Central time.

2. A partial eclipse of the Sun, March 25, will be visible in the North Atlantic Ocean, Greenland, Labrador, New Brunswick, Norway, British Isles, and Portugal.

3. A partial eclipse of the Sun, Aug. 20, will be visible in the Arctic Ocean, Eastern Europe and Western Asia.

4. A total eclipse of the Moon, Sept. 3, will be visible generally throughout North and South America. The beginning will be visible in the western parts of Europe and Africa and the end in the Pacific Ocean. The middle of the eclipse will be at $11^h\ 57^m$ P. M. Central time.

5. A partial eclipse of the Sun, Sept. 18, will be visible only in the South Pacific and Antarctic Oceans.

Further data concerning these eclipses will be given before they occur.

Occultation of the Pleiades.—The sky was densely clouded on the night of Dec. 10, at Northfield, and we presume it was the same elsewhere in the United States, since no reports have come of any observations of the occultation of the Pleiades.

A similar occultation will occur on the night of Feb. 3. It will differ from that of Dec. 10, in that the conjunction will occur earlier in the night, while the Moon will be farther toward the west, so that the effect of parallax will be very different. Also the path of the Moon, as seen from the centre of the earth will be 24′ farther to the north of the constellation. We give the following data so that the reader may construct for himself a chart similiar to that in our December number.

Time of conjunction in R. A.	= Feb. 3 $9^h\ 50^m.2$ Washington M. T.
	= Feb. 3 $8^h\ 58^m.4$ P. M. Central T.
Apparent R. A. of Moon and Alcyone	= $3^h\ 41^m\ 15^s.2$
Apparent Decl. of Alcyone	= + 23° 47′ 00″
Apparent Decl. of Moon	= + 24 31 05
Moon's hourly motion in R. A.	= + $142^s.8$
Moon's hourly motion in Decl.	= + 530″
Moon's equatorial horizontal parallax	= 57′ 50″ = 3470″
Moon's apparent semidiameter	= 15′ 47″ = 947″
Moon's meridian passage at Greenwich	= $6^h\ 26^m.6$ Greenwich M. T.
Moon's hourly change of meridian passage	= $2^m.22$

I have been interested in looking up the circumstances of the Moon's passages by the Pleiades during the year 1895, and find that in every case the course of the Moon lies to the north of that shown on the chart in our last number. Occultations of Alcyone, after Jan. 7, will be possible only as seen from extreme northern latitudes. The three stars *g*, *e* and *c* however will be occulted in our latitude, on some side of the earth, on each occasion. The following table giving the circumstances of the Moon's conjunction with Alcyone may help the reader to get some idea of where the occultations may be visible, as well as of the apparent irregularity of the Moon's motion.

CONJUNCTION OF THE MOON WITH ALCYONE IN 1895.

Date.	Central Time.	Moon east (−) or west (+) of 90th meridian.	Moon's Center north of Alcyone.	Occultation of some of the group visible from
	h m	h m	′	
Jan. 7	11 48 A. M.	− 8 45	32	Europe and Asia.
Feb. 3	8 58 P. M.	+ 2 13	44	North America.
March 3	3 44 A. M.	+ 10 46	51	Pacific Ocean.
30	9 12 "	− 5 58	49	Europe and Asia.
April 26	3 17 P. M.	+ 1 54	44	North America.
May 23	New Moon			
June 26	8 20 A. M.	− 1 28	46	North America.
July 17	5 54 P. M.	+ 9 55	56	Asia.
Aug. 14	2 27 A. M.	− 3 44	65	North America.
Sept. 10	9 15 "	+ 4 51	68	Asia.
Oct. 7	2 50 P. M.	− 11 46	63	Asia.
Nov. 3	8 46 P. M.	− 4 03	56	Europe and North America.
Dec. 1	4 23 A. M.	+ 5 22	55	North America and Asia.
Dec. 28	1 41 P. M.	− 7 48	62	Europe and Asia.

Mars and Pyrois.—I wish to make some remarks about a sentence in the November Number of *Astronomy and Astro-Physics*. It is on p. 715, Vol. XIII and reads as follows: "Nevertheless the cause of this predominance of the red and yellow tints upon the surface of ancient Pyrois is well known."

In a foot-note to this passage the translator says he does not know what or where Pyrois is.

I think the translator *has missed the sense entirely*. I have not now access to Schiaparelli's treatise in the original Italian; and even if I had, my knowledge of Italian is not so critical that I would venture to put my version against the translator's; still "hear me a few words."

In the first place, the sentence as it stands has no real connection with what precedes or with what follows:—this alone is cause of suspicion. For nearly half a century I have been familiar with the Latin itineraries,—and with the graphical names in the early and later middle ages, and of modern times. And no place called "Pyrois" is found in any of my books, maps, or itineraries.

In the second place Pyrois is the Greek name of *Mars*, and the usual one, but there is another. If you will look in the 20th chapter of the 2nd book of Cicero's *De Natura Deorum* you will find a very pretty passage, giving the names of all the planets; and it is noteworthy that the names of all as there given express the idea of *light* in some one of its many manifestations. I remembered of reading the passage when I was in college in 1847. Turning to it, I find as follows:

Saturni Stella.....φαίνων.....The shiner.
Jovis Stella.....φαέθων.....The beaming.
Stella Martis.....πυρό'εις.....The fiery.
Stella Mercurii....στέλβων.....The glittering.
Stella Veneris.....φωσφό'ρος.....The light bringer.

I omit many interesting clauses, so as to bring the planets together.

Had the translator used the word "fact" instead of "cause" all would be plain, and the sentence would harmonize both with what precedes and with what follows. "Nevertheless, the "fact" of this predominance, etc., etc.

If you will turn to Humboldt's Cosmos, you will find a pretty full statement of the ancient writers concerning the color of the stars, and you will find that Sirius is always spoken of as "fiery"—in one place, if my memory is not at fault the word "*flavus*" is used. Aratus says:

"*Fervidus ille Canis Stellarum luce refulget,*" and "*fervidus*" means *hot* or *burning*. So Sirius has changed color—but "ancient Pyrois" is *fiery* still;—was so in the beginning "and ever shall be" R. W. M.

The Chicago Academy of Sciences.—*Section of Mathematics, Astronomy and Physics, Dec. 11th.*—The regular monthly meeting was held at the Commerce Club, Professor G. W. Hough, President, in the Chair. After the transaction of routine business, the President introduced Dr. T. J. J. See, who read the paper of the evening on "*Helmholtz's Theory of the Heat of the Sun.*" The speaker began by referring to Helmholtz's paper in the *Philosophical Magazine*, for 1856, which he said appeared to be very little known to astronomers.

In this paper the illustrious physicist had given the formulæ for computing the heat of the Sun, but had not shown how the formulæ were derived. The speaker determined the potential of a homogeneous sphere upon itself, and derived the formulæ given by Helmholtz. He then proceeded to apply the formulæ to the contraction of the Sun. It was shown that in the condensation of the solar nebula enough heat had been developed to raise the temperature of a mass of water equal to the Sun to 27,000,000 degrees Centigrade. According to Pouillet's estimate of solar radiation an amount of heat is annually lost which would raise the temperature of a mass of water equal to the Sun 1.25° C. From this observed radiation it follows that the past duration of the Sun cannot exceed 21,600,000 years, if the radiation has been going on uniformly at its present rate. The speaker did not believe the radiation in past ages had been as great as at present, and hence he thought the duration of the Sun must be materially lengthened. By computation it was shown that all the heat developed by the nebula in condensing from infinite expansion to the orbit of Neptune was only 1/6600 part of that developed by the subsequent condensation; and that a contraction of 1/10000 part of the present solar radius would maintain the radiation for 2180 years. This corresponded to a contraction in the radius of 35 metres per year, which could not be observed for thousands of years. The speaker said all these results were true on the supposition that the Sun is homogeneous, but in the actual case would be considerably modified by the heterogeneity of the Sun. The general result of heterogeneity is to increase the total heat already lost by the Sun, and hence to increase its age; also to diminish the annual contraction necessary to maintain the present radiation. In conclusion the speaker regarded this theory of Helmholtz as firmly established; but he also referred to the insufficiency of the older theories. He had computed how long the Sun would radiate if its heat were due to combustion of pure carbon and pure oxygen in the right proportion to form carbon dioxide, and found that the combustion of the entire Sun would maintain radiation only for 1763 years. He discarded the theory of meteoric impact on the ground that it would sensibly increase the mass of the Sun, and hence accelerate the mean motions of the planets—which is contrary to observation.

In the discussion which followed, Professor Hough, Dr. Crew, Professor Chamberlin, and Professor McNeill took part.

Professor Chamberlin discussed the bearing of the paper on Geological Theories, and thought the time was too short for geological phenomena, which require at least 100,000,000 years for the development of the Earth.

Dr. See pointed out that the heterogeneity of the Sun would considerably lengthen the duration of its past radiation, and especially if it formerly radiated more slowly than at present. He thought the age of the solar system would probably have to be lengthened to 100,000,000 years. After considerable informal discussion, in which various members of the Academy participated, the meeting adjourned. *G.*

In POPULAR ASTRONOMY for October there is an illustrated description of three flashes of lightning observed by Mr. Stewart, one of which he likens to a string of beads. Such a flash is not entirely new. There was one seen by Gaston Plante, the inventor of the storage battery, about 23 years ago, and he named it the "Chaplet" flash. This is the first on record as far as I know and I have read pretty widely on that subject: the next was seen by myself just one week after Plante's, but I knew nothing of his discovery till I read it in *The Telegraphic Journal* of London, England, several weeks after. Mr. Stewart has witnessed the third, and the chaplet flash is fully descriptive and appropriate. The one I witnessed was during a heavy storm from the southwest and seemed to have ascended from the earth, and was drifting with the wind as I thought, the highest spot of light being decidedly east of the starting point.

My explanation is, a theory of my own, that electricity being visible or manifested only in connection with solid or ponderable matter, the wave motion of the ether which was started from below or above as you like, consumed the particles of solid matter which it met in its passage and thus made the light, or lightning. I propounded this theory some years ago. It has come to the front since and is being discussed now by the most eminent authorities, Lord Kelvin, Professor P. G. Tate and others.

DAVID FLANERY.

NOTICE

The entire plant of the Central Tennessee School of Mechanical Engineering at Nashville, Tenn., having been destroyed by fire, Nov. 14, 1893—and no suitable location being accessable, the management have decided to *remove the same* to Davenport, Iowa.

The new plant, consisting of the finest Machinery that money could buy—has been selected, and is now being erected at the latter place. The machinery will be started Dec. 20th, and all orders filled as usual.

All contracts heretofore made at Nashville, will be carried out at Davenport, and all correspondence should hereafter be addressed as below. With new machinery, new tools, and new patterns, we shall be able to give our patrons better results than ever, all lenses in our care are kept in the latest improved fire proof safes and all instrument in our hands for repairs, etc,, are also kept in fire proof vaults.

Our patrons will pardon our delay in correspondence during the past 30 days we were in a period of confusion. But hereafter shall resume our usual promptness in business matters. *Please note* the slight change in our name.

Address hereafter as follows:

"Central School of Mechanical Engineering," Davenport, Iowa.

BIBLIOGRAPHY OF ASTRONOMY.

The works can be obtained from W. Wesley and Son, 28 Essex Street, Strand, London.

AUBERTIN (J. J.) By order of the Sun to see his total eclipse, April 16, 1893, 1893, with illustrations, post 8vo., cloth, 1894. $1.25.

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PRINZ (W.) Agrandissements de photographies lunaires, Mare Imbrium, Bullialdus, Copernicus, 3 plates, 20 × 26 inches. Uccle, 1894. $1.15.

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PUBLISHERS' NOTICES.

The publication of a series of star charts, reduced from Poole Brothers' Planisphere, commenced in the February, 1893, issue of this magazine. The present issue completes the series. These charts have presented the appearance of the heavens for each month of the year, showing the form and boundaries of constellations, as well as locating individual stars. The clear marking of magnitudes, and the introduction of guiding lines, greatly aid the beginner in tracing the constellations. As these charts are of permanent value, many, whose subscriptions began with Vol. II, may wish to secure Vol. I, and so complete the series. Orders from such will be promptly filled.

Advertising space in POPULAR ASTRONOMY can be secured on application to the publisher.

To all whose subscriptions expired with the December number we are sending the present issue, presuming that they wish to renew their orders. We would, however, ask the favor of an immediate notice from all such, indicating their wishes in the matter.

This magazine, in attempting to meet, in the best way, the wants of the students and amateur world, as well as of the popular reader, has been materially aided by its friends. Many have sent the names of new subscribers, many more have sent addresses of persons interested in Astronomy, who, through a sample copy, have become subscribers. Members of Astronomical Societies and editors of papers have, in a generous way, extended the knowledge of the publication. Men who are carrying on a large correspondence have asked for a supply of our circulars that they might enclose them in the letters which they are sending out. In these and other ways a strong support has been given. These favors we acknowledge, and ask their continuance that we may find it financially possible to carry out the larger plans for the publication.

POOLE BROTHERS' NEW MAP OF THE MOON.—We have thought the new Map of the Moon, just published by the Poole Brothers, of Chicago, a work of so much merit that we are anxious to get it before the readers of this periodical. If it could be examined, we believe every teacher of Astronomy of the High School, Academy or College would want a copy, to aid in instruction pertaining to one of the most interesting members of the solar family. We have thought of a way to make it comparatively easy for anyone to obtain a copy of this fine new map and its accompanying indexes, and that is to offer it as a premium for subscribers to POPULAR ASTRONOMY.

We, therefore, make this offer:

1. Any new subscriber, sending us $3.15, will be entitled to one copy of the Map and Index and POPULAR ASTRONOMY for one year.

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It may be noticed that 15 cents has been added to prices named in our last issue; this is to enable us to *prepay* cost of map transportation.

This very favorable offer is an experiment, and we are not sure that it will be continued long, because of the considerable expense involved by all the parties who have been interested, to try it.

The publisher of ASTRONOMY AND ASTRO-PHYSICS desires to secure, by purchase or otherwise, thirty (30) copies of the January number (1894), of that publication. Forty cents a copy will be paid to anyone who will furnish one or more copies of that number, in perfect condition.

ASTRONOMY AND ASTRO-PHYSICS, Volumes XI (1892), XII (1893), XIII(1894), contain, each, nearly one thousand pages of current Astronomy for the respective years to which they belong. They furnish an ample review of modern Astronomical progress. These volumes, in pamphlet form, one or all, may now be obtained at $4.00 per volume.

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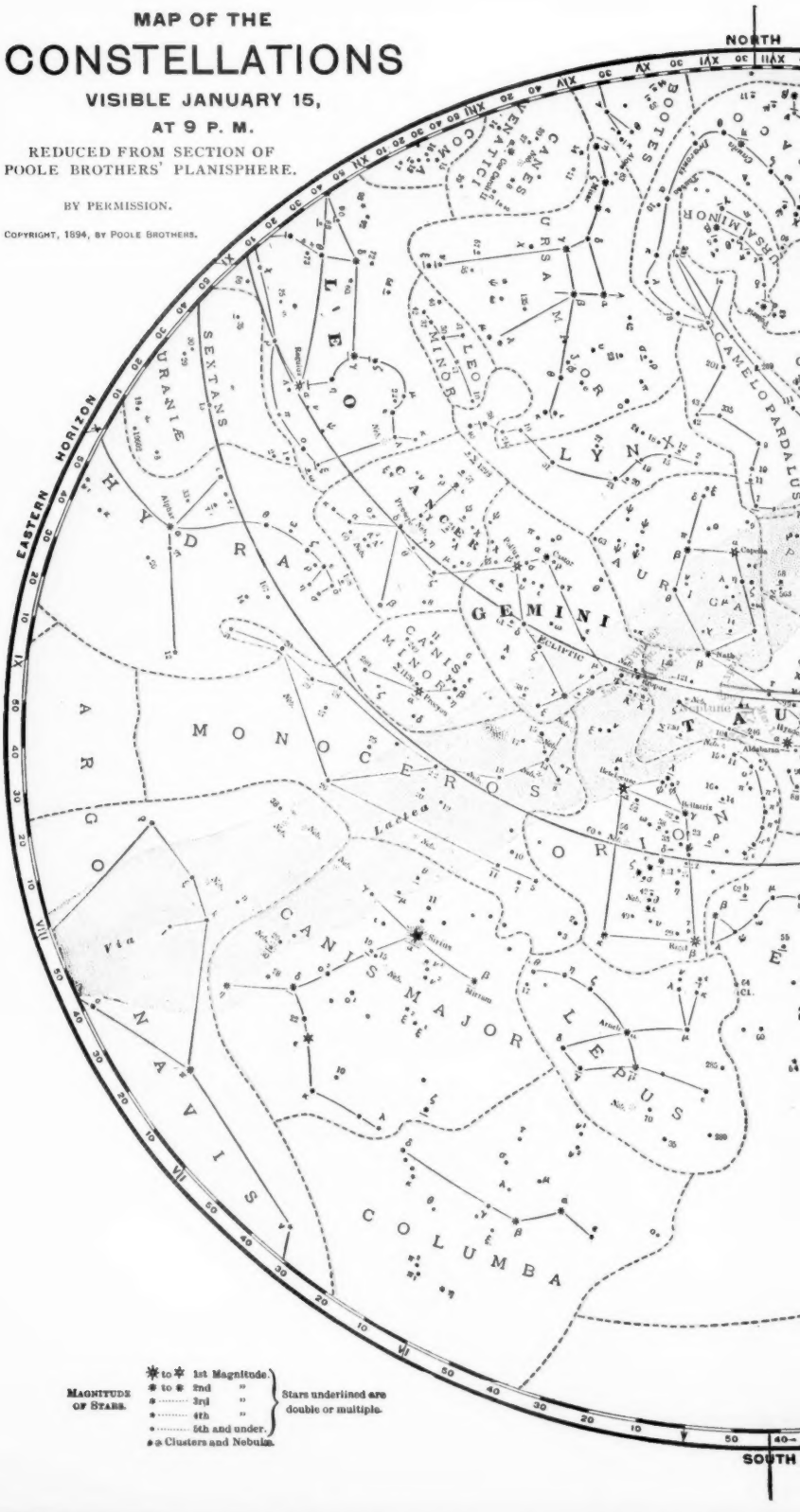

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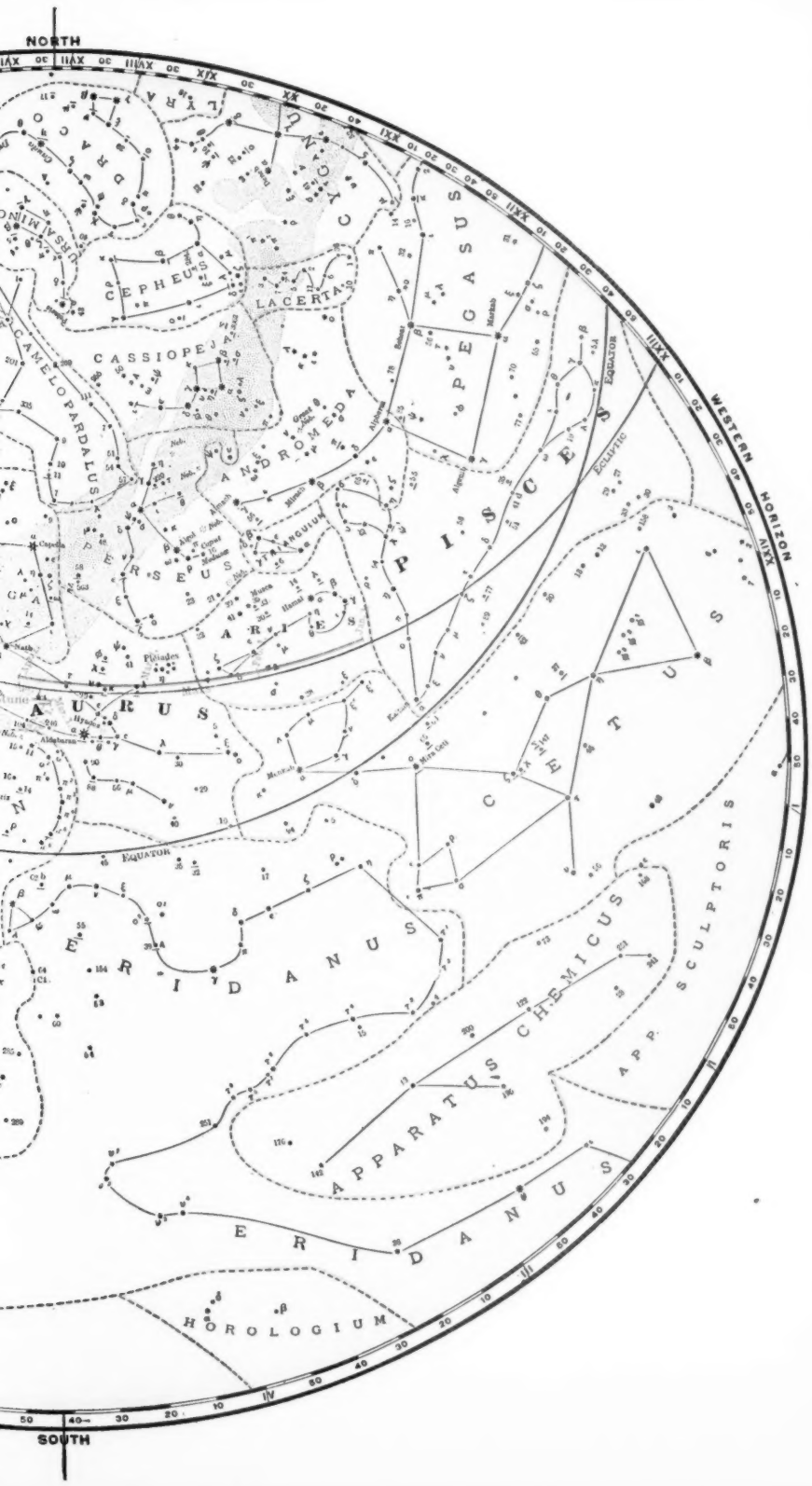
- ✱ to ✱ 1st Magnitude.
- ✱ to ✱ 2nd "
- ✱ 3rd "
- ✱ 4th "
- ✱ 5th and under.

Stars underlined are double or multiple.

✱ ✱ Clusters and Nebulæ.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